DOCUMENT RESUME

ED 315 659 CE 054 316

AUTHOR Tharp, Bill
TITLE Electronics. Module 1: Electronic Safety. Instructor's Guide.
INSTITUTION Missouri Univ., Columbia. Instructional Materials Lab.
SPONS AGENCY Missouri State Dept. of Elementary and Secondary Education, Jefferson City. Div. of Vocational and Adult Education.
PUB DATE 89
NOTE 91p.; For related documents, see CE 054 317-319.
AVAILABLE FROM Instructional Materials Laboratory, University of Missouri, 2316 Industrial Drive, Columbia, MO 65202 (Order No. 70-3701-I: $10.30; student reference $3.45; worksheets $2.35).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Competency Based Education; Educational Objectives; *Electricity; *Electronics; *Electronic Technicians; *Hand Tools; Industrial Arts; Occupational Information; *Occupational Safety and Health; Secondary Education; *Shop Curriculum
IDENTIFIERS Alternating Current

ABSTRACT

This guide contains instructor's materials for a three-unit secondary school course on electronic safety. The units are shop safety principles, hand tools, and alternating current safety and protection devices. The document begins with advice on its use and a cross-referenced table of instructional materials that show which materials in the guide (transparency masters, handouts, assignment sheets, and test items) are directed at which competency and instructional objectives. Each unit contains the unit objective, student objectives, a list of references, notes to the instructor, lesson plans, a unit test, and answers to the unit test. The lesson plans may include a glossary, information sheets, transparency masters, job sheets, assignment sheets, and test items. (CML)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ELECTRONICS

Module

1

ELECTRONIC SAFETY

ED315659

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Modules in this IML Electronics series

1: *Electronic Safety* by Bill Tharp
2: *Fundamentals of Electronics* by Jim Everett
3: *Digital Logic Application* by Ed Carter and Mark Murphy
4: *Circuit Construction Techniques* by Don Slack
5: *Semiconductor Devices and Applications* by John Chappell and Bill Franken
6: *Receivers and Transmitters* by Jim Everett
7: *Testing and Troubleshooting* by Don Slack
8: *Microprocessor and Computer Systems* by Don Slack
9: *Optical Electronics* by Bill Franken
10: *Electromechanical Devices and Controllers* by Ed Carter

The activity which is the subject of this report was supported in whole or in part by funds from the Department of Elementary and Secondary Education, Division of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect the position or policies of the Missouri Department of Elementary and Secondary Education or the Division of Vocational and Adult Education, and no official endorsement should be inferred.

ELECTRONICS

Module 1: Electronic Safety

by
Bill Tharp

Diane M. Davis, editor/project coordinator
Instructional Materials Laboratory
8 London Hall
University of Missouri-Columbia
Columbia, MO 65211

1989

Instructor's Guide
Catalog No. 70-3701-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, efforts and professionalism to develop curriculum for trade, technical and industrial education programs. This electronics guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future electronics curriculum modifications will begin with this guide. The electronics field is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Perryman, supervisor
Industrial Education
Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
Industrial Education
Department of Elementary and Secondary Education

ACKNOWLEDGMENTS

This electronics guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the electronics competency profile developed by industry and education professionals in the state.

When searching for current electronics materials to adopt or utilize in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these electronics materials.

Special appreciation is given to the writers (Ed Carter, John Chappell, Jim Everett, Bill Franken, Mark Murphy, Don Slack and Bill Tharp) for their self-motivation, reliability and technical expertise. IML employees Crystal Dietiker and Donna Curtis contributed greatly to the guide's production.

These industry representatives and educators contributed to the guide as members of the advisory committee.

Ed Carter, Columbia Area Career Center, Columbia
John Chappell, St. Fair Community College, Sedalia
Jim Everett, Platte Co. Area Vocational-Technical School (AVTS), Platte City
Bill Franken, Maple Woods Community College, Kansas City
Linda Miller, St. Louis Community College at Florissant Valley
Mark Murphy, Davis H. Hart Mexico AVTS, Mexico
Norman Peterson, University of Missouri-Columbia (PAVTE)
Don Slack, Graff Area Vocational Center, Springfield
Bill Tharp, Chillicothe AVTS
Charles Waibel and Judith Perryman, Division of Vocational & Adult Education, Department of Elementary and Secondary Education, Jefferson City

Educators who field-tested the guide in the classroom include the following.

Don Campbell, Boonslick AVTS, Boonville
John Chappell, St. Fair Community College, Sedalia
Bob Chenoweth, Chillicothe AVTS
Jim Everett, Platte Co. AVTS, Platte City
Don Kennison, Nichols Career Center, Jefferson City
Don Mallory, Cass County AVTS, Harrisonville
Linda Miller, St. Louis Community College at Florissant Valley
Norman Peterson, University of Missouri-Columbia (PAVTE)
Don Slack, Graff Area Vocational Center, Springfield
Lawrence Vance, Rolla AVTS
Mark Ward, Lewis & Clark Technical School, St. Charles

Support and contributions of IML staff members were instrumental to this module's development.

Harley Schlichting, director
Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
Crystal Dietiker, graphic artist II
Donna Curtis and Lori Holliday, word processors
Wei Li, graduate assistant

TABLE OF CONTENTS

Unit I: Shop safety principles 1

Unit II: Hand tools 39

Unit III: AC safety and protection devices 57

COMPETENCIES ADDRESSED IN THIS MODULE

A. Electronic Safety

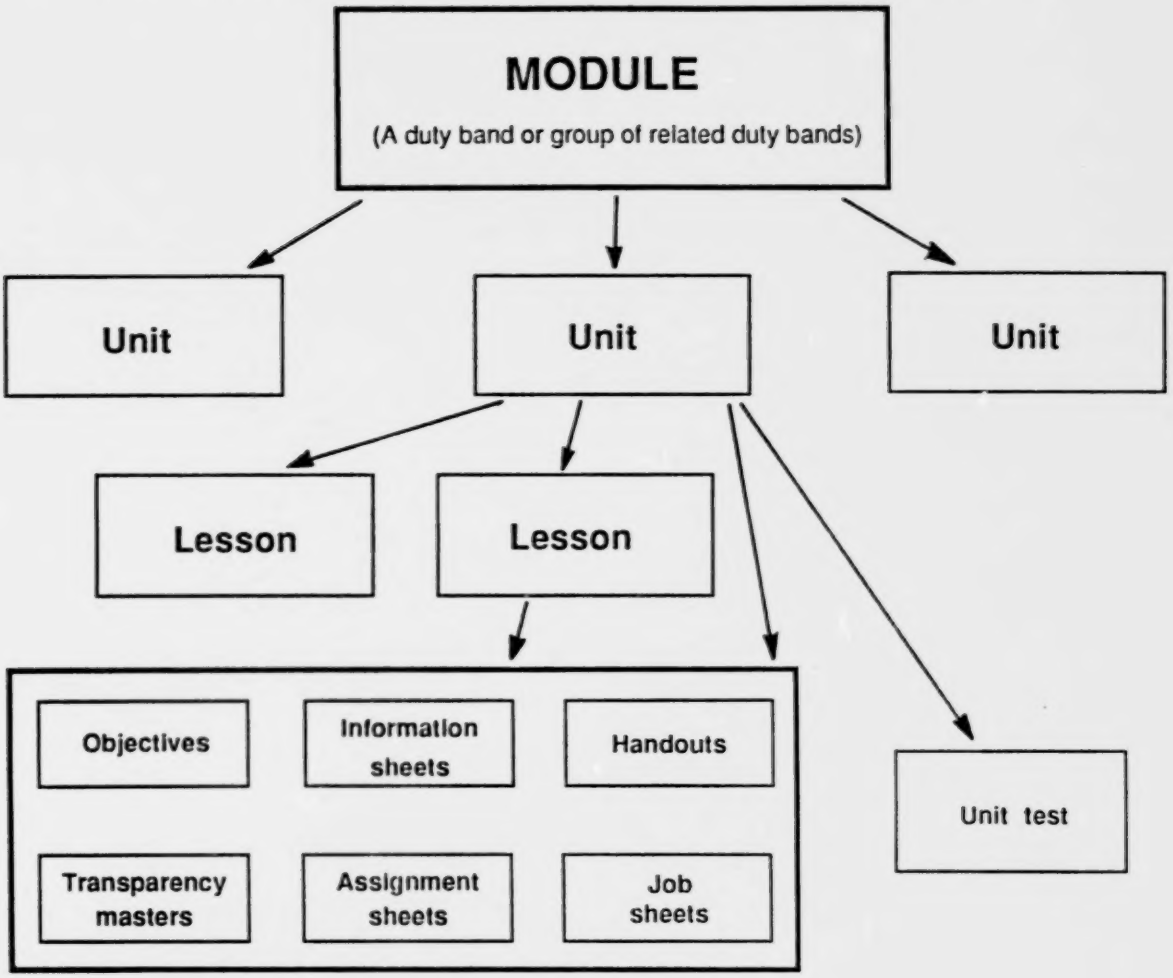
1. Identify various types, purposes and operation of fire extinguishers
2. Identify electrical hazards
3. Identify and practice shop safety
5. Demonstrate safe and proper use of hand tools
6. Identify hazard of RF radiation devices
7. Demonstrate safe and proper use of AC line operated equipment; i.e., isolation transformers, grounding, GFI

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Electronics guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

- **3** = **Mastery** - can work independently with no supervision
- **2** = **Requires supervision** - can perform job completely with limited supervision
- **1** = **Not mastered** - requires instruction and close supervision
- **N** = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, and so on. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives' intent. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. Handouts and transparency masters have been keyed in the information sheets for instructional use.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and direct the class's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion, however.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet

assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These welding unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Electronics guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all ten modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

MODULE 1: ELECTRONIC SAFETY

CROSS-REFERENCE TABLE OF INSTRUCTIONAL MATERIALS

Competency	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
A1	I 1.5-1.6		I 1.1	I 1.3		I 24-33	
A2	I 1.1-1.4	I 1.1,1.2		I 1.1		I 4-11,13-14,23	
A3	I 1.7-1.13		I 1.2	I 1.2,1.4		I 1-3,10-12,15-23	
A4							Circuit Construction module
A5	II 1.1-1.5		II 1.1		II 1.1	II 1-35	
A6	III 1.1-1.3			III 1.1		III 2-4,6-7,10-12,39	
A7	III 2.1-2.6, 3.1-3.6	III 2.1-2.5, 3.1-3.5	III 2.1-2.4	III 2.1		III 1,5,8-9,13-16, 19-20,22,30-36,38, 41-42,44	

MODULE: ELECTRONIC SAFETY

UNIT I: SHOP SAFETY PRINCIPLES

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify electrical and electronic hazards, tool safety rules and safe electrical cord use. This knowledge will be evidenced by performing the procedures outlined on the assignment sheets and completing the unit test to the specified score.

SPECIFIC OBJECTIVES

After completing of this unit, the student should be able to:

1.1 Match terms associated with electrical safety to definitions. (competency A2)

1.2 Name four hazards of working with electrical and electronic equipment. (competency A2)

1.3 Select true statements concerning electrical shock. (competency A2)

1.4 Select statements that describe the correct procedure when treating a victim of electrical shock. (competency A2)

1.5 Match the four fire classes (A, B, C and D) with the type of fire each class identifies. (competency A1)

1.6 State the use (class of fire) and operation of four common types of fire extinguishers. (competency A1)

1.7 Match colors used in color coding with the type of hazard designated. (competency A3)

1.8 Select statements which describe good general lab safety rules. (competency A3)

1.9 Select statements which describe good personal safety rules. (competency A3)

1.10 Select safety rules which describe hand tool safety precautions. (competency A3)

1.11 Select safety rules which describe power tool safety precautions. (competency A3)

1.12 Select statements which describe rules for safe use of electrical cords. (competency A3)

1.13 Indicate a willingness to follow safety rules by signing the student safety pledge sheet. (competency A3)

MODULE: ELECTRONIC SAFETY

UNIT I: SHOP SAFETY PRINCIPLES

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

1. Lesson 1: SHOP SAFETY

   a. Information outline

   b. Transparency masters

      TM 1.1: Shocking facts
      TM 1.2: Electrical cord danger spots

   c. Handouts

      HO 1.1: Know your fire extinguisher
      HO 1.2: Eye protection law

   d. Assignment sheets

      AS 1.1: Test electrical shock knowledge
      AS 1.2: Test safety rule knowledge
      AS 1.3: Test fire safety knowledge
      AS 1.4: Student safety pledge

   e. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Soldering Manual. 2nd ed. Miami: American Welding Society, Inc., 1978.

2. Schuler, Charles A.; Richard J. Fowler. Basic Electricity and Electronics. St. Louis: McGraw-Hill, 1988.

3. Floyd, Thomas L. Principles of Electronic Circuits. Columbus, OH: Charles E. Merrill, 1981.

4. Grob, Bernard. Basic Electronics. 5th ed. New York: McGraw-Hill, 1984.

5. Herrick, C. Electronic Assembly Techniques. Milwaukie, OR: Hickock Teaching Systems, Inc., 1970.

6. Manko, Howard H. Solders and Soldering. New York: McGraw-Hill, 1964.

7. Schlabach, T. D., and D. K. Rider. Printed and Integrated Circuitry. New York: McGraw-Hill, 1963.

B. Curriculum guide

1. Robertson, L. Paul. Basic Electronics I. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1980.

2. Hartman, Lonnie. Basic Electronics. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1987.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Provide students with copies of classroom shop rules, along with school-wide safety policies.

2. Cleaning a tarnished copper penny with a wire brush can be effective in demonstrating how oxidation of metal occurs.

3. Remind students of the state law concerning the use of safety glasses while soldering.

B. Suggested student activities

1. Help students plan and execute a class fire drill.

   a. Determine five areas in the classroom or school workshop where fires could start.

   b. Plan a safe exit route away from each of the possible fires.

   c. Locate the nearest fire alarm; make sure everyone knows how to operate it.

   d. Locate the nearest telephone. Find out fire emergency numbers or procedures for dialing the operator.

   e. Practice giving fire location directions over the telephone.

   f. Locate fire extinguishers which are closest to the possible fires determined in step a. Refer to HO 1.1 and check the type of extinguisher, type of fires it is used on and operating procedures.

   g. Determine which fire extinguisher should be used for each of the possible fires determined in step a.

   h. Appoint a fire marshall from among class members. This person will alert the class regarding the simulated fire, point out the nearest exit route, operate the fire alarm or call the fire department, use the proper fire extinguisher and direct firefighters when they arrive.

2. Tour an electronic circuit fabrication shop to observe assembly-line circuit fabrication techniques.

C. Suggested supplemental material (videotapes)

1. The Safety Factor. Katonah, NY: Circle Oak Productions, 1987. (Available with teacher's guide and quiz from 260 Katonah Ave. 10536, phone 914/232-9551)

2. The Electronics Industry (E-87-100). Sedalia, MO: State Fair Community College, 1987. (Available for purchase from SFCC; available for loan from Missouri Vocational Resource Center, phone 800/392-7217 or 314/882-9610)

MODULE: ELECTRONIC SAFETY

UNIT I: SHOP SAFETY PRINCIPLES

LESSON 1: SHOP SAFETY

I. Terms and definitions

A. Accident--any unplanned event occurring suddenly which causes personal injury or property damage

B. Circuit breaker--device which automatically opens the circuit like a switch if too much current is being drawn

C. Circuit overload--electrical circuit which draws more electrical current than it is designed to handle

D. Conductive materials--those through which electrical current flows easily (examples: copper, silver, gold, aluminum)

E. Electrical circuit--system of wires and cables which carry electricity to motors, appliances, heating elements and other devices operated by electricity

F. Electrical shock--jolt experienced when electrical current passes through a part of the body

WARNING: Electrical shock can cause serious burns and muscle damage. It can kill by stopping the heart or breathing--or both.

G. First aid--immediate care given to an accident or shock victim until medical help arrives

H. Fuse--device which opens the circuit ("burns out") when the circuit is overloaded

I. Insulating materials--those through which electrical current cannot flow easily (examples: rubber, cotton, wood)

J. Outlet adapter--electrical plug installed in an electrical outlet to permit connection of two or more electrical wires or cables to the outlet

NOTE: The adapter is called an "octopus" outlet if enough cables are attached to make the outlet look like a many-armed octopus.

K. Safety--state of being free from danger, personal risk or injury

L. Smoke alarm--device which senses smoke and gives off a shrill sound to alert people in the area that a fire may be starting

II. Hazards of working with electrical and electronics equipment

A. Electrical **shock** can occur if the body contacts an electrical circuit or is struck by lightning.

B. Electrical **burns** can happen if the body contacts an electrical circuit or is struck by lightning, or if the body is exposed to radio-frequency waves, X-rays or other forms of radiation.

C. Electrical **fires** can occur if wires, overheated because of an overloaded circuit, contact flammable materials.

D. Bodily injuries can be caused by the improper use of tools.

III. Facts about electrical shock (TM 1.1)

A. Current is usually considered more dangerous than voltage.

1. High voltage (low current) tends to knock the victim away from the circuit, minimizing exposure time.

2. High current tends to cause the body to adhere to the circuit so that the victim cannot let go.

a. At about 1 milliampere (0.0010 amperes), a slight shock will be felt.

b. At about 10 milliamperes (0.010 amperes), the shock is severe enough to paralyze muscles, but a person may be able to let go of the conductor.

c. At 20-50 milliamperes (0.020-050 amperes), the shock is usually fatal if it lasts for one second or more.

NOTE: Human body resistance varies from about 500,000 ohms when dry to about 300 ohms when wet. Because of this, voltages as low as 30 volts can cause enough current to be fatal. Any circuit with a potential of at least 30 volts must be considered dangerous.

B. The frequency of alternating current can be dangerous.

1. High-frequency energy can cause serious body burns.

Examples: Radio-frequency (RF) waves, radar waves, microwaves (as in microwave ovens)

2. High-frequency energy can arc from a conductor to the skin.

3. Low-frequency current (60 cycles per second) can be dangerous.

IV. Treating a victim of electrical shock

A. Safely remove the victim from contact with the source of electricity using the following procedure.

WARNING: Do not touch the electrical circuit or the victim unless the power is off or you are insulated.

1. Turn off electricity by means of a switch or circuit breaker or cut cable or wires with a wood-handled axe or insulated cutters, if available.

2. Use a dry stick, rope, leather belt, coat, blanket or any other nonconductor to separate the victim from the electrical circuit.

B. Call for assistance.

1. Others in the area may be more knowledgeable than you about treating the victim.

2. Another person can call for professional medical help while a trained person administers first aid.

C. Check victim's breathing and heartbeat.

NOTE: Time is life at this point!

1. If pulse is detectable but breathing has stopped, a trained person should administer mouth-to-mouth resuscitation until medical help arrives.

2. If heartbeat has stopped, a trained person should administer cardiopulmonary resuscitation.

   WARNING: Cardiopulmonary resuscitation can cause more harm than good to a victim unless the person administering the first aid has been trained in the proper procedure.

D. Administer first aid for shock and burns as necessary.

1. Use blankets or coats to help keep the victim as warm and comfortable as possible while waiting for help.

2. Raise victim's legs slightly above head level to help prevent shock.

3. If the victim has suffered burns, use this procedure.

   a. Cover your mouth and nostrils with gauze or a clean handkerchief to prevent breathing germs on the victim while treating the burns.

   b. Wrap burned area firmly with sterile gauze or clean linen or towels.

   WARNING: Do not attempt any other treatment of burns.

E. Continue treatment within your ability until medical help arrives.

V. Types of fires

A. Class A--fires that occur in ordinary combustible materials (wood, rags, paper or trash)

B. Class B--fires that occur in flammable liquids (gasoline, oil, grease, paints and thinners)

C. Class C--fires that occur in electrical and electronic equipment (motors, switchboards, circuit wiring, radios and television sets)

D. Class D--fires that occur in combustible metals (powdered aluminum and magnesium)

VI. Fire extinguisher types and uses (HO 1.1)

A. Water types

1. All water types are used for Class A fires only.

2. Stored pressure extinguishers operate by squeezing the handle or turning a valve.

3. Cartridge operated types operate by turning the cylinder upside-down and bumping it.

4. Water-pump tanks function by pumping the handle.

5. Soda acid extinguishers are operated by turning the cylinder upside-down.

B. Foam type

1. Use for Class A or B fires.

2. Operate by turning cylinder upside-down.

C. Carbon dioxide type (CO_2)

1. Use for Class B or C fires.

2. Operate by pulling the pin and squeezing the lever.

D. Dry chemical type (universal type)

1. Use for Class B or C fires.

2. Operate by pulling pin or rupturing cartridge and squeezing lever.

NOTE: Fire extinguishers are not effective for Class D fires. Instead, smother metal fires with dry sand, dirt, salt or soda ash.

E. Halon

1. Stand back 10 feet, hold upright and direct at the fire's base, sweeping from side to side.

2. Use for Class C fires.

3. Halon is best for Class C electrical fires because it is not corrosive.

WARNING: A high concentration of burnt halon gas can be hazardous to one's health.

VII. Safety color coding

A. Green

1. Applied to nonhazardous parts of machine and equipment surfaces, like nameplates and bearing surfaces

2. Designates safe areas of equipment and is also used to show location of safety equipment and first-aid materials

B. Yellow

1. Applied to operating levers, wheels, handles and hazardous parts that may cause stumbling, falling, snagging or tripping

2. Designate caution

C. Orange

1. Applied to electrical switches, interior surfaces or doors, fuses and electrical power boxes, and moveable guards and parts

2. Indicates dangerous parts of equipment which may cut, crush, shock or otherwise physically injure someone

D. Red

1. Applied to buttons or levers of electrical switches used for stopping machinery and to all equipment--such as gasoline cans--which are fire hazards

2. Designates fire hazards and fire-fighting equipment

NOTE: The color red is also applied to other fire-fighting equipment, such as fire alarms, axes and emergency exits.

E. Blue

1. Used to identify equipment which is being repaired or is defective and should not be operated

2. Designates "out of order" or "defective"

F. Ivory

1. Applied to label edges, vise jaws and tool rests edges where extra light reflection is important

2. Helps show tool and equipment moving edges more clearly

VIII. General lab safety rules

A. Keep all hand tools clean and in safe working order.

B. Report any defective tools, test equipment or other equipment to the instructor.

C. Do not remove any safety devices, (i.e. ground straps, switch covers, etc.) without the permission of the instructor.

D. Do not operate or energize any circuit that could be hazardous without first receiving instruction on how to do so safely.

E. Report all accidents to the instructor, regardless of nature or severity.

F. Turn off power before leaving test equipment or circuits being worked on.

G. Do not use any solvent without first determining its properties and safe use. Solvents should be used only in well-ventilated spaces.

H. Keep the laboratory floor clean of scraps and litter.

I. Clean up any spilled liquids immediately.

J. Store all cleaning rags in metal cans or containers.

NOTE: Cleaning rags could contain oil.

IX. Personal safety rules

A. When working on or near rotating machinery, secure loose clothing and tie hair (if long).

B. Isolate line (power) voltages from ground by means of isolating transformers.

C. Check all line (power) cords before using; if the insulation is brittle and/or cracked, do not use and report to the instructor.

D. When measuring voltages with a meter and test probe, be careful not to connect yourself to a voltage of any value.

E. Be certain of floor insulation by tile, rubber mats or rubber-soled shoes.

F. When measuring voltages expected to be greater than 30 volts, turn off or disconnect live circuits before connecting test equipment.

WARNING: Treat voltages of 30 volts or more with great respect.

G. It is recommended that only equipment with a polarized (three-pronged) plug be used.

H. Do not defeat the purpose of any safety device such as fuses, circuit breakers or interlocks; shorting across these devices could cause excessive current flow and destroy or seriously damage equipment being worked on, as well as cause a fire.

I. Do not carry sharp-edged or pointed tools in pockets.

J. Do not indulge in horseplay or play practical jokes in any work area.

K. Wear gloves and goggles when required.

L. Do not wear rings or jewelry when working with mechanical or electrical devices.

M. Exercise good judgment and common sense.

X. Hand tool safety precautions

WARNING: Electronic technicians are required to use hand tools and power tools to build the mechanical parts of electronic equipment. Many accidents are caused by the thoughtless or careless use of tools. Accidents result from using a tool to do something for which it was not intended. Learn to use tools in the right way.

A. Keep tools in proper working condition.

B. Always put a handle on a file before using.

C. Use caution with soldering irons or guns; they can burn and cause fires.

D. Exercise care in using nose pliers and diagonal cutters; they can pinch and cut.

E. Do not use long-nosed pliers as a wrench.

F. Ease up on the pressure just before a hacksaw completes its cut.

WARNING: Many knuckles and hands have been cut when this was forgotten.

G. Whenever possible, pull on a wrench; don't push.

H. Be sure hammer heads and screwdriver blades are fastened tightly in their handles.

I. Use safety glasses or goggles when soldering or unsoldering.

XI. Power tool safety precautions

WARNING: Power tools usually operate on 120 volts. This voltage can cause serious shock, burns or death. Always check the power tool before using it. Be sure the cord is in good condition and that the plug and switch are not broken.

A. Keep the cord clear of the work.

B. When drilling, use a sharp drill bit; pressure on a dull drill bit can cause an accident.

C. Securely fasten the work being drilled.

WARNING: The drill will turn both the bit and the work, which can cause injury.

D. Be sure hands are dry before using electric tools.

E. Keep power tool guards in place; they are for your protection.

F. Operate power tools only after instruction in the proper uses.

G. Wear safety goggles or glasses when operating power tools. Flying chips can cause permanent damage to eyes. (HO 1.2)

H. Power cords and switches should be checked prior to power tool use.

XII. Electrical cord safety rules (TM 1.2)

A. Do not overload a circuit by connecting numerous cords to a single outlet by means of "octopus" adapters.

B. Do not pull on the cord to disconnect; use the plug.

C. Do not use electrical cords with frayed or worn insulation; replace cords as necessary.

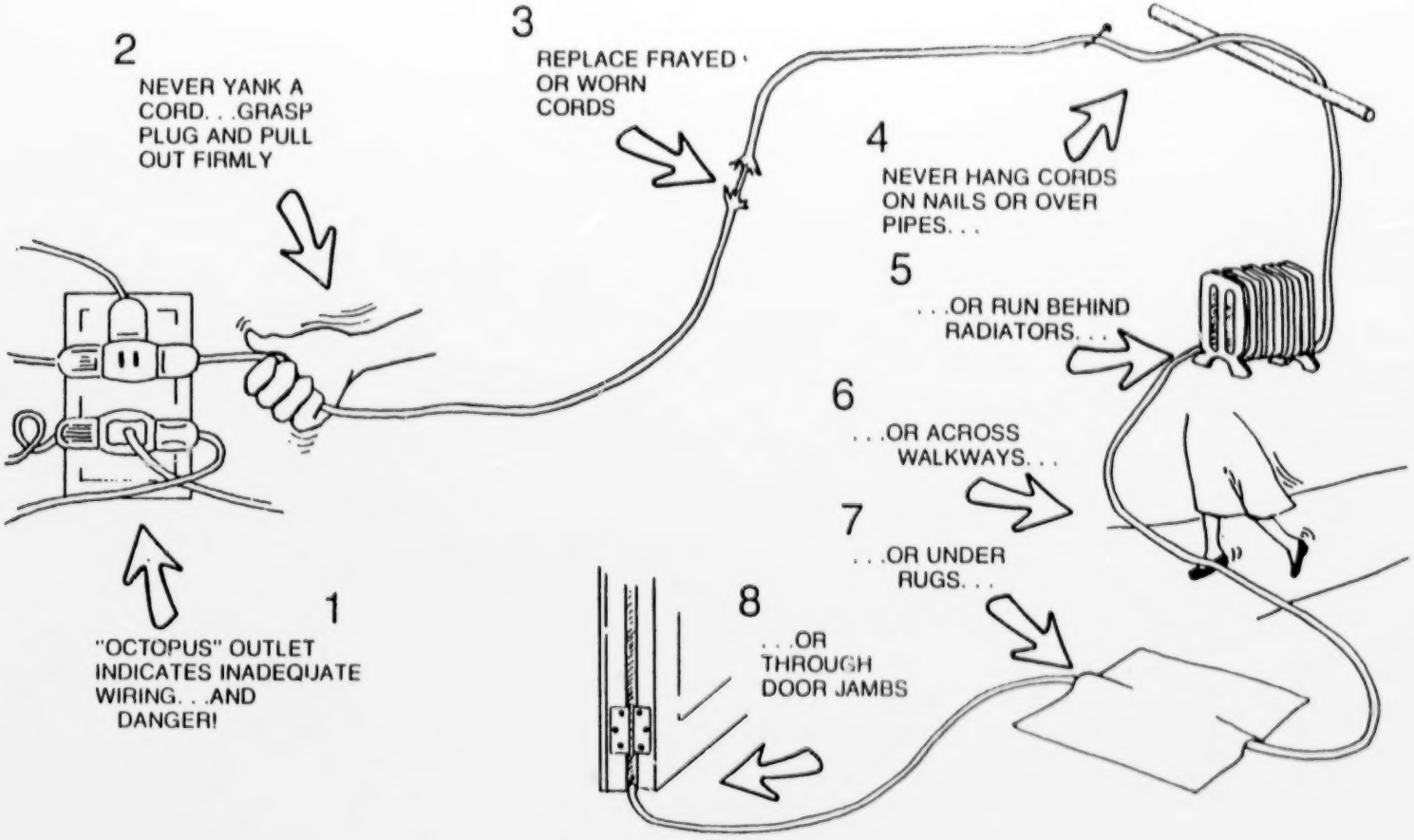
D. Do not suspend electrical cords over nails or pipes.

E. Never run electrical cords near heating devices, like space heaters or radiators; across walkways; under carpets or rugs; or through door jambs.

SHOCKING FACTS

60-Hertz current values affecting humans

Current value	Effects
1 mA (.001 amperes)	Mild sensation (tingle)
10 mA (.010 amperes)	Muscle spasms. Shock is sufficient to prevent voluntary muscle control--you will not be able to let go of the conductor.
20-50 mA (.20-.50 amperes)	Shock is sufficient to be fatal.
More than 100mA	Death is caused almost immediately.


2
NEVER YANK A CORD. . .GRASP PLUG AND PULL OUT FIRMLY
3
REPLACE FRAYED OR WORN CORDS
4
NEVER HANG CORDS ON NAILS OR OVER PIPES. . .
5
. . .OR RUN BEHIND RADIATORS. . .
6
. . .OR ACROSS WALKWAYS. . .
7
. . .OR UNDER RUGS. . .
8
. . .OR THROUGH DOOR JAMBS
1
"OCTOPUS" OUTLET INDICATES INADEQUATE WIRING. . .AND DANGER!

ELECTRICAL CORD DANGER SPOTS

TYPE EXTINGUISHER	WATER TYPE				FOAM	CARBON DIOXIDE	DRY CHEMICAL	
	STORED PRESSURE	CARTRIDGE OPERATED	WATER PUMP TANK	SODA ACID	FOAM	CO2	CARTRIDGE OPERATED	STORED PRESSURE
TYPES OF FIRES								
CLASS A: WOOD, PAPER, TRASH HAVING GLOWING EMBERS	YES	YES	YES	YES	YES	NO	NO	NO
CLASS B: FLAMMABLE LIQUIDS, GASOLINE, OIL, PAINT GREASE, ETC.	NO	NO	NO	NO	YES	YES	YES	YES
CLASS C: ELECTRICAL EQUIPMENT	NO	NO	NO	NO	NO	YES	YES	YES
CLASS D: COMBUSTIBLE METALS	*	*	*	*	*	*	*	*
METHOD OF OPERATION	SQUEEZE HANDLE OR TURN VALVE	TURN UPSIDE DOWN AND BUMP	PUMP HANDLE	TURN UPSIDE DOWN	TURN UPSIDE DOWN	PULL PIN, SQUEEZE LEVER	RUPTURE CARTRIDGE, SQUEEZE LEVER	PULL PIN, SQUEEZE LEVER

*** DO NOT USE FIRE EXTINGUISHER. SMOTHER FIRE WITH DRY SAND, GRAPHITE, DIRT, OR SODA ASH.**

KNOW YOUR FIRE EXTINGUISHER

EYE PROTECTION LAW

SENATE BILL NO. 519

78TH GENERAL ASSEMBLY

AN ACT

Requiring all students and teachers to wear approved eye protective devices when participating in certain vocational, industrial arts, and chemical-physical laboratory courses of instruction.

Be it enacted by the General Assembly of the State of Missouri, as follows:

Section 1. 1. Every student, teacher and visitor is required to wear an industrial quality eye protective device when participating in or observing any of the following courses in schools, colleges, universities or other educational institutions:

(1) Vocational, technical, industrial arts, chemical, or chemical-physical shops or laboratories involving exposure to the following: hot molten metals, or other molten materials; milling, sawing, turning, shaping, cutting, grinding or stamping of any solid materials; heat treatment, tempering, or kiln firing of any metal or other materials; gas or electric arc welding, or other forms of welding processes; repair or servicing of any vehicle; caustic or explosive materials;

(2) Chemical, physical, or combined chemical-physical laboratories involving caustic or explosive materials, hot liquids or solids, injurious radiations or other hazards not enumerated.

Section 2. As used in this act, "Industrial Quality Eye Protective Devices" means devices meeting the standards of the American National Standard Practice for Occupational and Educational Eye and Face Protection, Z87.1 - 1968, and subsequent revisions thereof, approved by the American National Standards Institute, Inc.

Section 3. The state board of education and the coordinating board for higher education shall prepare and circulate to each public and private educational institution in this state instructions and recommendations for implementing the eye safety provisions of this act.

TEST ELECTRICAL SHOCK KNOWLEDGE

Match terms on the right with definitions. Answers may be used more than once.

____	1.	0.1 ampere	a.	Safety
____	2.	Unplanned event	b.	First aid
____	3.	Emergency care	c.	Accident
____	4.	Being free from danger	d.	Electric shock
____	5.	Heart or breathing stopped	e.	1 milliampere
____	6.	Muscle paralysis	ab.	10 milliamperes
____	7.	Just feeling a shock	ac.	100 milliamperes
____	8.	Jarring, shaking feeling	ad.	Death
____	9.	Event involving personal injury		
____	10.	Unable to let go		
____	11.	Fatal if more than one second		

Choose the option which best answers the question or completes the statement.

____ 12. A shock lasting for one second or more at about _____ amperes is usually fatal.

a. 0.001
b. 0.02
c. 0.01
d. 0.1

____ 13. The human body's resistance to electrical current varies from about _____ ohms wet to _____ ohms dry.

a. 30, 500,000
b. 300, 500,000
c. 300,000, 500,000
d. 500,000, 600,000

____ 14. Because of varying body resistance to electrical current, any circuit with a potential of at least ____ volts must be considered dangerous.

a. 30
b. 300
c. 3,000
d. 30,000

15. List two ways to remove a victim from contact with an electrical circuit.

a.

b.

16. List three hazards that could be encountered in working with electrical circuits and/or electronics equipment.

a.

b.

c.

TEST SAFETY RULE KNOWLEDGE

Choose the option which best answers the question or completes the statement.

___ 1. Which indicates a potential unsafe condition?

a. Soldering iron on stand
b. Line cord insulation frayed
c. Equipment isolated by transformer
d. One hand behind back

___ 2. If you notice that a line cord was frayed, which of the following would be the best course of action?

a. Notify the instructor or supervisor
b. Unplug it from the wall
c. Repair it or replace it
d. All of the above

___ 3. Which of the following currents would be fatal to the human body if applied for one second or more?

a. 0.0001 ampere
b. 0.001 ampere
c. 0.01 ampere
d. 0.1 ampere

___ 4. If a classmate was being shocked and you couldn't find the switch or anything to pull him away with, which of the following could be used to cut the wires?

a. A kitchen knife
b. A power saw
c. Diagonal cutters
d. A fire axe

___ 5. If a fire suddenly occurred, which color would help locate the fire extinguisher?

a. Yellow
b. Red
c. Green
d. Orange

___ 6. When working with electrical test equipment, be certain that the _____ is turned off before leaving it for any reason.

a. Lights
b. Water
c. Power
d. Sound

___ 7. If you have, or see anyone else have an accident, _____ immediately.

a. Report it to the supervisor
b. Call the principal
c. Turn your back
d. Correct the condition that caused it

___ 8. An electric shock is severe enough to cause muscle paralysis at about _____ milliamperes.

a. 1
b. 10
c. 100
d. 1,000

9. List six general safety rules that apply to lab sessions.

   a.
   b.
   c.
   d.
   e.
   f.

10. List six specific (personal) safety rules that apply to the student during lab sessions.

   a.
   b.
   c.
   d.
   e.
   f.

TEST FIRE SAFETY KNOWLEDGE

Match extinguishers on the right to appropriate descriptors or hazards. Answers may be used more than once.

____ 1.	Switchboard fire	a.	Class A
____ 2.	Wood fire	b.	Class B
____ 3.	Oil fire	c.	Class C
____ 4.	Must be turned upside down	d.	Pressurized water
____ 5.	Most commonly used	e.	Foam
____ 6.	Do <u>not</u> use on Class B or C	ab.	CO_2
____ 7.	Contains water only	ac.	Soda acid
____ 8.	Carbon dioxide	ad.	Dry chemical (universal type)
____ 9.	Paper fire	ae.	Class D
____ 10.	Use on flammable liquids		
____ 11.	Combustible metal fire		

Choose the option which best answers the question or completes the statement.

____ 12. The class of fire that would normally be found in an electronics lab is _____ .

a. A
b. B
c. C
d. D

____ 13. To put out a class A fire, a _____ extinguisher is normally used.

a. Pressurized water
b. Soda acid
c. Foam
d. All of the above

____ 14. In an electrical fire, never use a _____ extinguisher.

a. Carbon dioxide
b. Pressurized water
c. Dry chemical
d. None of the above

____ 15. Which of the following types of extinguishers usually must be turned upside-down before use?

a. CO_2
b. Dry chemical and water
c. Pressurized water and foam
d. Soda acid and foam

STUDENT SAFETY PLEDGE

_____, who is enrolled in Vocational Electronics Program, will operate both test equipment and electrical and/or electronics equipment as a part of the shop experience, providing that parents or guardians give written permission, when applicable.

It is understood that each student will be given proper instruction both in use of the equipment and in correct safety procedures concerning it before being allowed to operate it alone. The student must assume responsibility for following safe practices; we therefore ask that the following is agreed upon.

1. To follow all safety rules for the shop
2. To use a piece of equipment only after receiving permission from the instructor
3. To withhold asking permission to use a particular piece of equipment unless instructed in its proper use and have a score of 100% has been achieved on the safety test for that equipment
4. To report and accident or injury to the teacher immediately

I subscribe to the above.

Date _____ Student's signature _____

I hereby give my consent to allow my son/daughter to operate all tools and equipment necessary in carrying out the requirements of the course in which he/she is enrolled.

Date _____ Parent's signature _____
(if applicable)

Parents are cordially invited to visit the shop to inspect equipment and observe it in operation.

ANSWERS TO ASSIGNMENT SHEET 1.1

1. ac
2. c
3. b
4. a
5. ad
6. ab
7. e
8. d
9. c
10. ab
11. ac
12. d
13. b
14. a
15. a. Pull off with belt, coat, blanket or any other nonconductor
    b. Open switch to circuit
16. Any three of the following:
    a. Electrical shock
    b. Electrical fires
    c. Burns
    d. Injury from tool misuse

ANSWERS TO ASSIGNMENT SHEET 1.2

1. b
2. a
3. d
4. d
5. b
6. c
7. a
8. b
9. Any six of the following:
   Keep all hand tools clean and in safe working order.
   Report any defective tools, test equipment or other equipment to the instructor.
   Do not remove any safety devices, (i.e. ground straps, switch covers, etc.) without the permission of the instructor.
   Do not operate or energize any circuit that could be hazardous without first receiving instruction on how to do so safely.
   Report all accidents to the instructor regardless of nature or severity.

Turn off power before leaving test equipment or circuits being worked on.
Do not use any solvent without first determining its properties and how to use it safely.
Keep the laboratory floor clean of scraps and litter.
Clean up any spilled liquids immediately.
Store all cleaning rags in metal cans or containers.

10. Any six of the following:
When working on or near rotating machinery, secure loose clothing and tie hair (if long).
Isolate line (power) voltages from ground by means of isolating transformers.
Check all line (power) cords before using; if the insulation is brittle and/or cracked, do not use and report to the instructor.
When measuring voltages with a meter and test probe, be careful not to connect yourself to a voltage of any value.
Be certain of floor insulation by tile, rubber mats or rubber-soled shoes.
When measuring voltages expected to be greater than 30 volts, turn off or disconnect live circuit before connecting test equipment.
It is recommended that only equipment with a polarized (three-pronged) plug be used.
Do not defeat the purpose of any safety device such as fuses, circuit breakers or interlocks.
Do not carry sharp-edged or pointed tools in pockets.
Do not indulge in horseplay or play practical jokes in any work area.
Wear gloves and goggles when required.
Do not wear rings or jewelry when working with mechanical or electrical devices.
Exercise good judgment and common sense.

ANSWERS TO ASSIGNMENT SHEET 1.3

1. c
2. a
3. b
4. e and ac
5. ab
6. d
7. d
8. b, c and ab
9. a, c and d
10. ad
11. ae
12. c
13. d
14. b
15. d

MODULE: ELECTRONIC SAFETY

UNIT I: SHOP AND SAFETY PRINCIPLES

UNIT TEST

Match terms on the right with definitions on the left.

____ 1. State of being free from danger, personal risk or injury

____ 2. Any unplanned event occurring suddenly which causes personal injury or property damage

____ 3. Immediate care given to an accident or shock victim until medical help arrives

____ 4. Jolt experienced when electrical current passes through a part of the body

____ 5. Materials through which electrical current flows easily

____ 6. Materials through which electrical current cannot flow easily

____ 7. System of wires and cables which carry electricity to motors, appliances, heating elements and other devices operated by electricity

____ 8. Electrical circuit which draws more electrical current than it is designed to handle

____ 9. Electrical plug installed in an electrical outlet to permit connection of two or more electrical wires or cables to the outlet

____ 10. Device which opens the circuit ("burns out") when the circuit is overloaded

____ 11. Device which automatically opens the circuit like a switch if too much current is drawn

____ 12. Device which senses smoke and gives off a shrill sound to alert people in the area that a fire may be starting

a. Accident
b. Circuit breaker
c. Conductive materials
d. Electrical circuit
e. Electrical shock
ab. First aid
ac. Fuse
ad. Insulating materials
ae. Outlet adapter
bc. Overloaded circuit
bd. Safety
be. Smoke alarm

Choose the option which best answers the question or completes the statement.

____ 13. Which is a false statement about electrical shock?

a. Electrical shock can hurt, but it can't kill.
b. Electrical shock can be felt.
c. Current is usually considered more dangerous than voltage.
d. High current tends cause the body to adhere to the circuit so that the victim cannot let go.
e. None of the above

___ 14. Which is an untruth about electrical shock?

a. At about 10 milliamperes (0.010 amperes) the shock is severe enough to paralyze muscles, but a person may be able to let go of the conductor.
b. At about 100 milliamperes (0.10 amperes) the shock is usually fatal if it lasts for one second or more.
c. The frequency of alternating current is not a factor in electrical shock.
d. Low-frequency current (60 cycles per second) can be dangerous.
e. None of the above

___ 15. Which is a correct treatment for a victim of electrical shock?

a. Cut the electrical conductor by means of ordinary metal tin snips to remove current from the victim.
b. Use a dry stick, leather belt, rope, blanket, coat or any other nonconductor of electricity to separate the victim from the electrical circuit.
c. Do not call for assistance--this may cause too large a crowd to gather.
d. Assume that you know more than anyone else about how to treat the victim.
e. If victim has suffered burns, apply butter or grease to burned areas.

___ 16. Which is an incorrect electrical shock treatment?

a. If heartbeat has stopped, administer cardiopulmonary resuscitation if trained in the proper technique.
b. Use blankets or coats to help keep the victim as warm and comfortable as possible while waiting for help.
c. Raise victim's head slightly above leg level to help prevent shock.
d. Always continue treatment within your ability until medical help arrives.
e. When treating burns, cover your mouth and nostrils with gauze or a clean handkerchief to prevent breathing germs on the victim while treating the burns.

___ 17. Which is <u>not</u> a good general lab safety rule?

a. Keep all hand tools clean and in safe working order.
b. Do not remove any safety devices (i.e. ground straps, switch covers, etc.) without the permission of the instructor.
c. Do not operate or energize any circuit that could be hazardous without first receiving instruction on how to do so safely.
d. Report all accidents to the instructor regardless of nature or severity.
e. Do electrical experiments in the dark to improve visibility.

___ 18. Which is <u>not</u> a good general lab safety rule?

a. Do not use any solvent without first determining its properties and safe uses.
b. Store all cleaning rags in metal cans or containers.
c. Wear long hair so people can pull you to safety more easily.
d. Report any defective tools, test equipment or circuits being worked on.
e. Turn off power before leaving test equipment or circuits being worked on.

___ 19. Select the statement which does not belong.

a. When working on or near rotating machinery, secure loose clothing and tie back long hair.
b. Check all line (power) cords before using; if the insulation is brittle and/or cracked, <u>do not use</u> and report to the instructor.
c. Be certain that floor is insulated by tile, rubber mats or rubber-soled shoes.
d. It is recommended that only equipment with a two-pronged plug be used.
e. Do not carry sharp-edged or pointed tools in pockets.

___ 20. Which is an inappropriate personal safety rule?

a. Wear gloves and goggles when required.
b. Do not defeat the purpose of any safety devices such as fuses, circuit breakers or interlocks.
c. When measuring voltages expected to be greater than 10 volts, turn off or disconnect live circuit before connecting test equipment.
d. When measuring voltages with a meter and test probe, be careful not to connect yourself to a voltage of any value.
e. Isolate line (power) voltages from ground by means of an isolation transformer.

___ 21. Which describes a safety rule for hand tool use?

a. A large screwdriver can be used as a pry-bar.
b. Always put a handle on a file before using it.
c. Whenever possible push on a wrench--don't pull on it.
d. Hand tool use is obvious--instructions aren't necessary.
e. The use of hand tools seldom causes accidents.

___ 22. Select the statement which does <u>not</u> describe power tool safety precautions.

a. Dull drill bits can be used if sufficient pressure is applied.
b. Securely fasten the work being drilled.
c. Power tool guards should not be removed.
d. Wear safety goggles or glasses when operating power tools.
e. Power cords and switches should be checked before using a power tool.

___ 23. Select the statement that describes safe use of electrical cords.

a. "Octopus" adapters are appropriate for connecting numerous cords to a single outlet.
b. Disconnect electrical cables by pulling on the cord.
c. Repair frayed or worn cords with cellophane tape.
d. Do not suspend electrical cords over nails or pipes.
e. Electrical cords can be routed under rugs to prevent people from tripping over them.

Match the color codes and fire classes on the right to the type of hazard they designate.

____ 24. Operating levers, wheels, handles and other hazardous parts which could cause falling, snagging or tripping

____ 25. Fire hazards and fire-fighting equipment

____ 26. Fires that occur in ordinary combustible materials

____ 27. Nonhazardous parts of machines and equipment surfaces

____ 28. Fires that occur in electrical and electronic equipment

____ 29. Fires that occur in combustible metals

____ 30. Equipment which is being repaired or is defective and should not be operated

____ 31. Label edges, vise jaws and edges of tool rests where extra light reflection is important

____ 32. Fires that occur in flammable liquids

____ 33. Electrical switches, interior surfaces of doors, fuses and electrical power boxes, and movable guards and parts

a. Blue

b. Class A

c. Class B

d. Class C

e. Class D

ab. Green

ac. Ivory

ad. Orange

ae. Red

bc. Yellow

34. Name four hazards of working with electrical or electronic equipment.

a.

b.

c.

d.

ANSWERS TO UNIT TEST

1.	bd	(A3)
2.	a	(A3)
3.	ab	(A3)
4.	e	(A2)
5.	c	(A2)
6.	ad	(A2)
7.	d	(A2)
8.	bc	(A2)
9.	ae	(A2)
10.	ac	(A2, A3)
11.	b	(A2, A3)
12.	be	(A3)
13.	a	(A2)
14.	c	(A2)
15.	b	(A3)
16.	c	(A3)
17.	e	(A3)
18.	c	(A3)
19.	d	(A3)
20.	c	(A3)
21.	b	(A3)
22.	a	(A3)
23.	d	(A2, A3)
24.	bc	(A1)
25.	ae	(A1)
26.	b	(A1)
27.	ab	(A1)
28.	d	(A1)
29.	e	(A1)
30.	a	(A1)
31.	ac	(A1)
32.	c	(A1)
33.	ad	(A1)

34. a. Electrical shock (A2)
b. Electrical burns
c. Electrical fires
d. Injury from misuse of tools

MODULE: ELECTRONIC SAFETY

UNIT II: HAND TOOLS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify basic hand tools and list maintenance procedures for tools. The student should also be able to clean and lubricate pliers. This knowledge will be evidenced by completion of the job sheet and unit test to specified score.

SPECIFIC OBJECTIVES

After completion of the lesson in this unit, the student should be able to:

1.1 Identify basic hand tools. (competency A5)

1.2 Match tools to uses. (competency A5)

1.3 List factors to consider when selecting tools. (competency A5)

1.4 List maintenance procedures for tools. (competency A5)

1.5 Demonstrate the ability to clean and lubricate pliers. (competency A5, JS 1.1)

MODULE: ELECTRONIC SAFETY

UNIT II: HAND TOOLS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Lesson plan

1. Lesson 1: HAND TOOLS

a. Information outline

b. Handout

HO 1.1: Hand tools

c. Job sheet

JS 1.1: Clean and lubricate pliers

D. Unit test

E. Answers to unit test

REFERENCES

A. Curriculum guide

1. Hartman, Lonnie. Basic Electronics. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1987.

MODULE: ELECTRONIC SAFETY

UNIT II: HAND TOOLS

LESSON 1: HAND TOOLS

I. Types of hand tools (HO 1.1)

- A. Pliers
  - 1. Long-nose chain pliers (sometimes called needle-nose pliers)
  - 2. Diagonal-cutting pliers
  - 3. Lineman's side-cutting pliers
  - 4. Combination slip-joint pliers
- B. Screwdrivers
  - 1. Flat-blade (slot-head) screwdriver
  - 2. Phillips™ head (cross-point) screwdriver
- C. Saws
  - 1. Hacksaw
  - 2. Hole saw
- D. Adjustable wire strippers
- E. Electrician's six-in-one tool
- F. Wrenches
  - 1. Adjustable wrench
  - 2. Hex and spline wrench
- G. Nut driver
- H. Drill and drill bits
- I. Wire gauge
- J. Hemostat clamp
- K. Ball-peen hammer
- L. Files (flat, half-round and precision)
- M. Punches (center, square-hole and round-hole)
- N. Pocket knife

II. Tool use

A. Long-nose chain pliers

1. Holding components
2. Heat sink
3. Shaping and forming small conductors

B. Diagonal-cutting pliers

1. Cutting wire and component leads
2. Stripping insulation from wire

C. Lineman's side-cutting pliers

1. Cutting heavier conductors and cables
2. Cutting small screws
3. Stripping insulation from wires
4. Forming large conductors

D. Combination slip-joint pliers

1. Loosening small- to medium-size nuts and bolts
2. Holding and turning

E. Screwdrivers--removing or tightening screws and bolts (flat-blade or Phillips™)

F. Hacksaw

1. Cutting chassis metal
2. Cutting bolts or metal parts

   Examples: antenna installation parts or screws and bolts too large to cut with side-cutting pliers

G. Electrician's six-in-one tool

1. Crimping solderless connections
2. Cutting wire
3. Stripping insulation from wire
4. Shearing bolts
5. Thread gauges
6. Length gauges for stripping

H. Nut drivers

1. Holding nuts or bolt heads

2. Tightening or loosening nuts or bolts

I. Hex and spline wrenches

1. Tightening or loosening socket cap screws

2. Tightening or loosening set screws

J. Hole saws and hole punches

1. Cutting holes up to four inches in diameter

2. Punching round or square holes in metal

III. Factors to consider when selecting tools

A. Tool size should be matched to the work most frequently encountered.

B. Tools should be specifically designed for electronic use when possible.

1. The handles of pliers should have insulation.

2. The handles of screwdrivers should have insulation.

C. Purchasing high-quality tools is less expensive in the long run.

D. Know the specifications before purchasing a tool.

NOTE: When in doubt about what tools are best, consult a practicing electronics specialist in the area.

Examples: Pliers, long-chain nose, 5", with plastic-grip handles and serrated jaws; Flat-blade screwdriver, electrician's round shank, 6" x 3/16" blade w/cushion grips

IV. Tool maintenance procedures

A. Screwdrivers

1. Regrind worn or damaged flat-blade screwdrivers.

2. Discard damaged Phillips™ screwdrivers.

B. Pliers

1. Keep pliers clean and rust-free.

2. Keep cutting edges sharp and smooth.

3. Keep pliers working freely.

4. Repair or replace damaged handle insulation.

C. Adjustable wrenches: Keep worm gears clean and lubricated.

D. All tools: Identify tools by labeling with an electric-vibrator pen or scratch awl.

HAND TOOLS

Ball-Peen Hammer

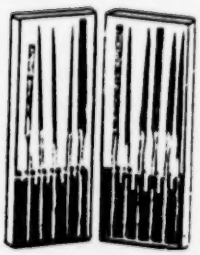
Center Punch

Square Hole Punch

Flat File

Half-Round File

Round Hole Punch



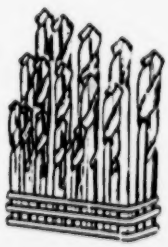
Precision Files

Adjustable Wire Strippers

Nut Driver

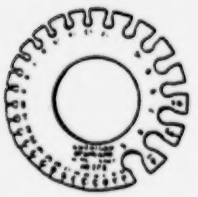
Electrician's Six-in-One Tool

Drill



Drill Bits

Hex and Spline Wrenches



Wire Gauge

Hemostat Clamp

Adjustable Wrench

Long Nose Chain Pliers

Flat Blade (slot-head) Screwdriver

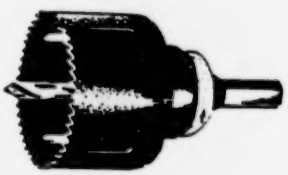
Diagonal Cutting Pliers

Phillips Head Screwdriver

Lineman's Side Cutting Pliers

Hacksaw

Combination Slip-Joint Pliers



Hole Saw

CLEAN AND LUBRICATE PLIERS

Equipment:

Pliers
Solvent
Oil
Solvent tray or equivalent

Procedure:		Evaluation 3	2	1	N
1.	Lay pliers in tray.	—	—	—	—
2.	Pour solvent into tray until pliers are submersed.	—	—	—	—
	NOTE: If pliers have cushion grips, immerse only the head.				
3.	Open and close pliers several times while submersed.	—	—	—	—
4.	Let pliers set for three or four minutes in the solvent.	—	—	—	—
5.	Remove from solvent.	—	—	—	—
6.	Open and close rapidly until pliers work freely.	—	—	—	—
	NOTE: If pliers do not work freely, repeat steps 3-6.				
7.	Wipe residue from plier joint with a cloth or paper towel.	—	—	—	—
8.	Apply two or three drops of oil to joints of the pliers.	—	—	—	—
9.	Work the pliers until the oil has penetrated the joint.	—	—	—	—
10.	Wipe excess oil from pliers.	—	—	—	—
Average of above evaluation*		—	—	—	—

*This average is the student's partial evaluation for competency A5: Demonstrate safe and proper use of hand tools.

MODULE: ELECTRONIC SAFETY

UNIT II: HAND TOOLS

UNIT TEST

Identify tools by matching each tool to the appropriate choice below.

a. Adjustable wrench

b. Adjustable wire strippers

c. Combination slip-joint pliers

d. Diagonal cutting pliers

e. Electrician's six-in-one tool

ab. Flat blade (slot-head) screwdriver

ac. Hacksaw

ad. Hex and spline wrenches

ae. Hole saw

bc. Lineman's side-cutting pliers

bd. Long-nose chain pliers

be. Phillips™ (cross-point) screwdriver

___ 1.

___ 2.

___ 3.

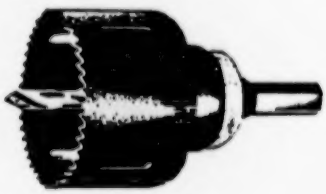
___ 4.

___ 5.

___ 6.

___ 7.

___ 8.



___ 9.

___ 10.

___ 11.

___ 12.

Identify tools by matching each one to the appropriate choice below.

a. Ball-peen hammer

b. Center punch

c. Drill and drill bits

d. Flat file

e. Half-round file

ab. Hemostat clamp

ac. Nut driver

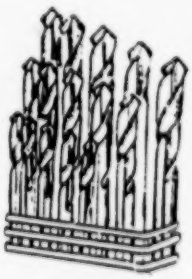
ad. Precision files

ae. Round-hole punch

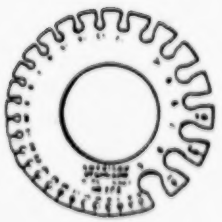
bc. Square-hole punch

bd. Wire gauge

___ 13.



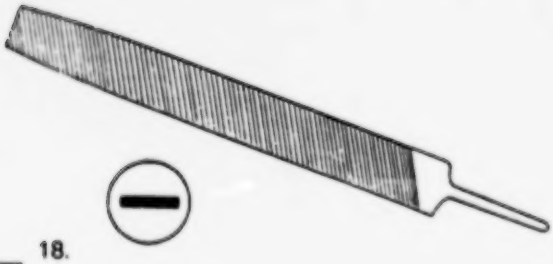
___ 14.



___ 15.

___ 16.

___ 17.



___ 18.

___ 19.

___ 20.

___ 21.

___ 22.

___ 23.

Match tools to appropriate uses.

____	24.	Removing or tightening screws or bolts (flat or Phillips™ head)	a. Combination slip-joint pliers
____	25.	Crimping solderless connections, cutting wire, stripping insulation from wire, shearing bolts, threading gauges	b. Diagonal-cutting pliers
____	26.	Holding components, heat sink, or shaping and forming small conductors	c. Electrician's six-in-one tool
____	27.	Cutting holes up to four inches in diameter; punching round or square holes in metal	d. Hacksaw
____	28.	Holding nuts or bolt heads; tightening or loosening nuts or bolts	e. Hex and spline wrenches
____	29.	Cutting chassis metal, bolts or metal parts	ab. Hole saws and hole punches
____	30.	Cutting heavier conductors and cables, cutting small screws, stripping insulation from wires or forming large conductors	ac. Lineman's side-cutting pliers
____	31.	Cutting wire and component leads; stripping insulation from wire	ad. Long-nose chain pliers
____	32.	Tightening or loosening socket cap screws or set screws	ae. Nut drivers
____	33.	Loosening small- to medium-sized nuts and bolts; holding and turning	bc. Screwdrivers

34. List three factors to consider when selecting tools.

    a.

    b.

    c.

35. List three maintenance procedures for pliers.

    a.

    b.

    c.

ANSWERS TO UNIT TEST (A5)

1. bd
2. d
3. bc
4. c
5. ab
6. be
7. ac
8. ae
9. b
10. e
11. a
12. ad
13. ac
14. c
15. bd
16. ab
17. a
18. d
19. e
20. ad
21. b
22. bc
23. ae
24. bc
25. c
26. ad
27. ab
28. ae
29. d
30. ac
31. b
32. e
33. a

34. Any three of the following:
Tool size should be matched to the work most frequently encountered.
Tools should be specifically designed for electronic use whenever possible (insulation on handles).
Purchasing quality tools is less expensive in the long run.
Know the specifications before purchasing a tool.

35. Any three of the following:
Keep pliers clean and rust-free.
Keep cutting edges sharp and smooth.
Keep pliers working freely.
Repair or replace damaged handle insulation.

MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to identify hazards of RF (radio frequency) radiation devices, demonstrate safe and proper use of AC line-operated equipment and demonstrate safe circuit measurement techniques. This knowledge will be evidenced by completing the unit test to the specified score.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms and definitions. (competency A6)

1.2 Identify microwave frequencies and hazards. (competency A6)

1.3 Identify biological effects of exposure to laser beams. (competency A6)

2.1 Match terms and definitions. (competency A7)

2.2 Identify characteristics of fuses. (competency A7)

2.3 Identify circuit breaker uses. (competency A7)

2.4 Match switches with schematic symbols. (competency A7)

2.5 Identify grounding principles. (competency A7)

2.6 Select true statements about isolation and isolation transformer principles. (competency A7)

3.1 Identify terms and definitions. (competency A7)

3.2 Differentiate between the types of multimeters. (competency A7)

3.3 Identify ammeter uses and operation. (competency A7)

3.4 Identify procedures for measuring voltage. (competency A7)

3.5 List safety precautions when measuring resistance. (competency A7)

MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: RF RADIATION AND LASER BEAM HAZARDS

   a. Information outline

   b. Assignment sheet

      AS 1.1: RF radiation and laser hazards

   c. Answers to assignment sheet

2. Lesson 2: PROTECTION DEVICES

   a. Information outline

   b. Transparency masters

      TM 2.1: Three-wire grounding-power outlet
      TM 2.2: Neon-light test for ground
      TM 2.3: Neon-light test for correct wiring
      TM 2.4: Current paths from AC power
      TM 2.5: Isolation transformers

   c. Handout

      HO 2.1: Fuses and fuse holders
      HO 2.2: Circuit breakers
      HO 2.3: Switches and their schematic symbols
      HO 2.4: Ground-fault interrupters

   d. Assignment sheet

      AS 2.1: Protection devices

   e. Answers to assignment sheet

3. Lesson 3: GENERAL MEASUREMENT CONCEPTS

   a. Information outline

   b. Transparency masters

      TM 3.1: Analog multimeter (Simpson 260)

TM 3.2: Digital multimeter
TM 3.3: Correct amperage measurements
TM 3.4: Correct voltage measurements
TM 3.5: Correct resistance measurements

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Floyd, Thomas L. Principles of Electronic Circuits. Columbus, OH: Charles E. Merrill, 1981.

2. Gates, Earl. Introduction to Electronics. New York: Delmar, 1987.

3. Grob, Bernard. Basic Electronics. 5th ed. New York: McGraw-Hill, 1984.

4. Schuler, Charles A.; Richard J. Fowler. Basic Electricity and Electronics. St. Louis: McGraw-Hill, 1988.

B. Curriculum guide

1. Vorderstrasse, Ron. General Electronics Technician. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1987.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Additional information on fuses, switches and measurement has been included in this unit for the student's better understanding of AC safety and protection devices. This general information does not key directly to a particular item on the competency profile.

MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

LESSON 1: RF RADIATION AND LASER BEAM HAZARDS

I. Terms and definitions

A. Laser--light emission device; acronym for light amplification by stimulated emission of radiation

B. Microwave--frequency band of electromagnetic transmission between 30 MHz and 300 MHz

C. Radiation--emission of energy through space or through a material medium in the form of waves

D. Wavelength--distance in space between two points with the same magnitude and direction in a propagated wave

II. Microwaves

A. Electromagnetic radiation

1. Wave lengths are between radio broadcast frequencies and infrared.

2. The microwave frequency band is 30 MHz to 300 MHz.

3. Frequencies that pose biological hazards are those between approximately 100 MHz and 30 GHz.

B. Mode of action on biological tissues

1. Microwave radiation can induce bulk heating effects in molecules.

2. It can cause death or blindness at moderate power levels.

3. Eyes are most susceptible to frequencies around 3000 MHz, when cataract formation is significant due to lens heating.

4. The body penetration depth of a microwave signal decreases with frequency.

5. At levels too low to produce significant heating, microwaves can affect heart action.

6. The hazard of microwave exposure depends upon the frequency, intensity and signal exposure duration.

7. Vital organs, eyes and the skin are all susceptible to radiation burns.

C. Precautions to take with microwave equipment

1. Avoid prolonged or repeated exposure to RF radiation.

2. Be aware of power levels and frequency capabilities of equipment you are working with.

3. Do not operate equipment without proper shields in place.

4. Do not defeat any safety interlock devices on equipment.

III. Lasers

A. In contrast to a conventional light emitter, lasers have a small-beam diameter and low-beam divergence.

1. High light beam intensities

2. Travel considerable distances

B. Biological effects

1. Biological effects of laser radiation are essentially the same as those from ultraviolet and infrared radiation, but its intensity has unique implications.

2. The light intensity of lasers could previously be approached only by the sun, nuclear weapons, burning magnesium or arc lights.

3. The retina is most susceptible to laser radiation damage due to the intensity of the laser beam.

4. Just as for visible light, laser absorption is selective.

5. There is a greater skin hazard for dark-skinned persons than for light-skinned persons. As a rule, if no vision hazard is present, a skin hazard will not result.

C. Precautions for all laser installations

1. Never attempt to work on laser equipment on which you have not been trained.

2. Do not align the laser with the naked eye or look along the axis of the beam.

3. Do not look into the primary beam; avoid looking at a reflection of the beam.

4. Wear safety eye-wear of an appropriate optical density during the firing of a laser.

RF RADIATION AND LASER HAZARDS

1. The microwave band is from _____ MHz to _____ MHz.
2. Biological hazards exist mostly between _____ MHz and _____ GHz.
3. RF radiation can cause death or blindness at _____ power levels.
4. At power levels too low to cause heating, microwaves can still affect _____ .
5. _____ , _____ and _____ are all susceptible to radiation burns.
6. List three precautions that should be taken when around RF transmission.

   a.

   b.

   c.
7. Laser is an acronym for _____ .
8. A laser has _____ intensities and can be projected for _____ distances.
9. The _____ is most susceptible to laser radiation damage.
10. List three precautions to be taken when lasers are present.

    a.

    b.

    c.

ANSWERS TO AS 1.1

1. 30,000

2. 100, 30

3. Moderate

4. Heart action

5. Vital organs, eyes, skin

6. Any three of the following:
   Avoid prolonged or repeated exposure.
   Be aware of power levels and frequency capabilities of equipment.
   Do not operate equipment without proper shields in place.
   Do not defeat safety interlock devices.

7. Light amplification by stimulated emission of radiation

8. High, considerable

9. Retina

10. Any three of the following:
    Work only on equipment on which you have been trained.
    Do not align laser with the naked eye.
    Do not look into primary beam or its reflection.
    Wear safety eye-wear of the appropriate optical density.

MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

LESSON 2: PROTECTION DEVICES

I. Terms and definitions

A. Circuit breaker--protective device that opens when excessive current flows in a circuit; can be reset

B. Fuse--metal conductor that melts at a predetermined current level

C. Ground fault--condition in which current returns directly to ground; causes an imbalance between hot and neutral wires to the load

D. Ground fault interrupter (GFI)--protection device designed to break the power circuit if a ground fault exists

E. Isolation transformer--one-to-one transformer that isolates the secondary voltage from the power line

F. Switch--device used by operator to control circuit power

II. Fuses (HO 2.1)

A. General information

1. Automatically interrupt the circuit when current becomes excessive

2. Current rating less than that required to melt the circuit conductors or components

B. Fuses must be matched to the application.

Example: A fuse designed to be used at 32 volts or less at a specific current is not interchangeable with one designed for use in 250-volt circuits. A short-circuit current in a 250-volt system could possible arc across a 32-volt fuse.

C. "Slow-blow" fuses

1. Used with loads that present high starting currents (such as motors starting under load)

2. "Slow-blow" fuses should not be interchanged with any other types of fuses.

D. A fuse should be located only in the hot lead to the load.

1. An open fuse placed in a neutral lead would result in a dangerous potential to ground.

2. A grounding conductor must never be interrupted.

III. Circuit breakers (HO 2.2)

A. Circuit breakers are essentially relays designed to trip at predetermined current levels.

B. Circuit breakers are reusable components, whereas fuses are not.

C. The same rules apply to circuit breakers as to fuses.

1. Placed between power supply and load

2. Matched to fit application

3. Should be located only in the hot lead to the load

IV. Switches (HO 2.3)

A. Device used to control circuit power at the will of the operator

1. Should match current and voltage specifications of circuit values

2. Used only in hot side of power supply (same as fuses and circuit breakers)

B. Types of switches

1. Single pole-single throw (SPST)

2. Single pole-double throw (SPDT)

3. Double pole-single throw (DPST)

4. Double pole-double throw (DPDT)

5. Normally open push button (NOPB)

6. Normally closed push button (NCPB)

V. Grounding (TM 2.1-2.4)

A. Electrocution hazards exist where there's a difference in potential.

1. Voltages in AC power transmission systems are in reference to earth ground.

2. The ground conductor is physically connected to earth ground.

WARNING: This means that it is <u>not</u> necessary to touch two wires to be electrocuted. Contact with only <u>one</u> energized conductor and ground can <u>kill</u>.

3. The best way to ensure that no potential difference exists between two points is to connect them both to ground.

a. This renders both points safe to each other and everything else connected to ground.

b. Every conducting object that does not <u>have</u> to be energized should be grounded.

B. One side of an AC line connected to ground

1. The three-wire grounded outlet

2. Neutral wire connected to ground

3. Testing a three-wire outlet for ground and correct wiring

a. Neon-light test for presence of ground

b. Neon-light test for correct wiring

C. Ground fault paths

1. Line-to-ground path of power line current: Current returns directly to ground via a ground conductor rather than via a neutral conductor.

2. The proper path of power line current is line to neutral. Current enters the hot line and leaves through a neutral line. (Currents are the same.)

D. Ground-fault interrupter (GFI) (HO 2.4)

1. A protection device that compares hot and neutral-line currents supplying a load

2. If currents are not equal (ground-fault condition), the GFI breaks the circuit.

VI. Isolation transformers (TM 2.5)

A. Isolation transformers are one-to-one transformers which completely isolate the secondary from the power line.

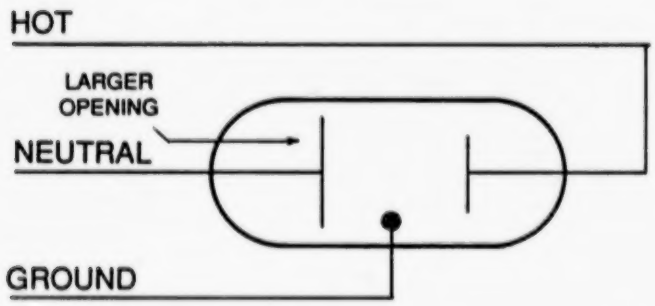
B. The following problems can be overcome by the use of an isolation transformer.

1. Many AC-line operated pieces of equipment have the chassis connected to one side of the AC line. The chassis should be connected to the neutral-grounded side.

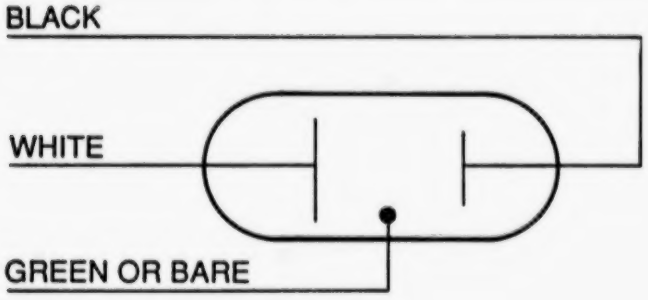
2. If the equipment does not have a power transformer and incorrect wiring exists in the AC outlet or a polarized plug has been defeated, a "hot" chassis can exist, creating a shock hazard.

3. A short circuit can be created when connecting grounded test equipment to the chassis.

THREE-WIRE GROUNDING POWER OUTLET

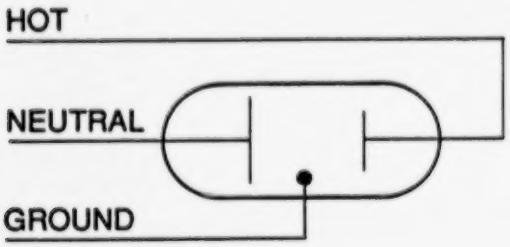


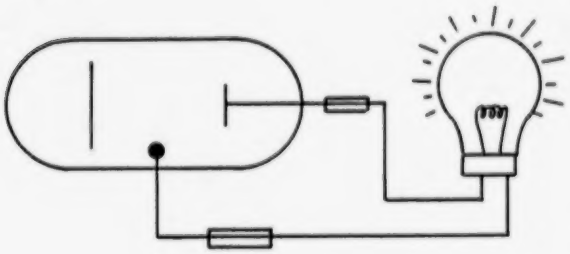
TERMINAL ASSIGNMENTS



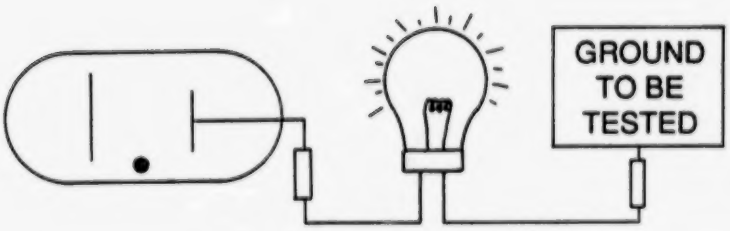
CORRECT WIRING

NEON-LIGHT TEST FOR GROUND

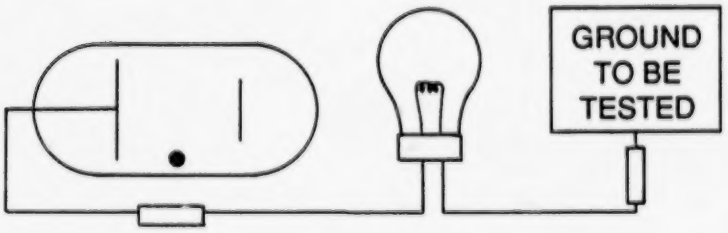




Lamp should light when connected between hot and neutral.

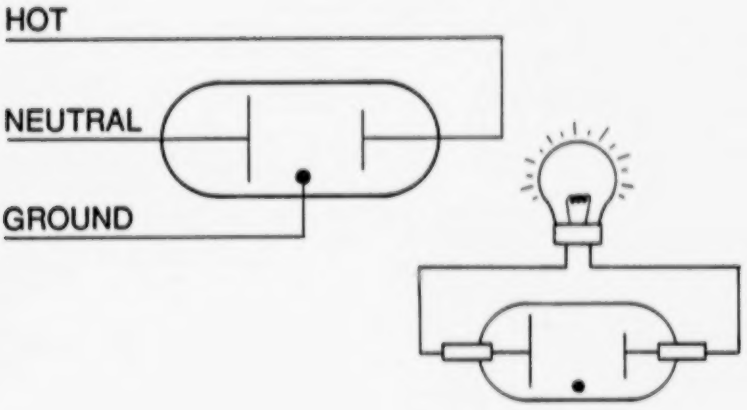


Lamp should light when connected between hot and ground.

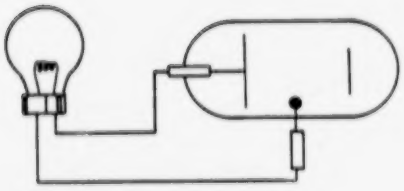


Lamp should not light when connected between neutral and ground.

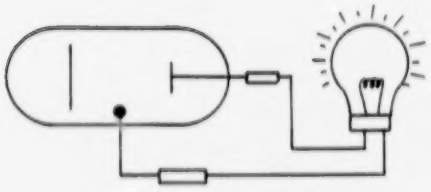
NEON-LIGHT TEST FOR CORRECT WIRING



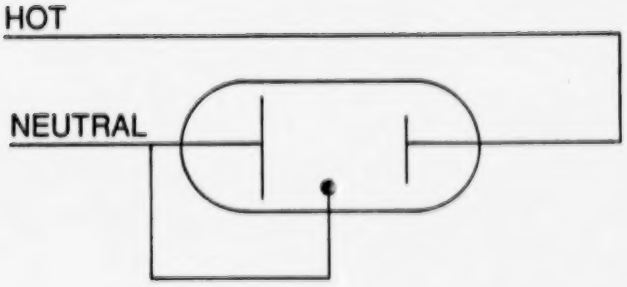
Lamp lights when connected between hot and neutral.



Lamp should not light when connected between neutral and ground.

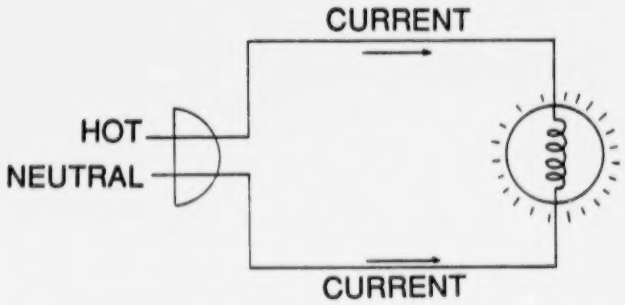


Lamp should light when connected between hot and ground.

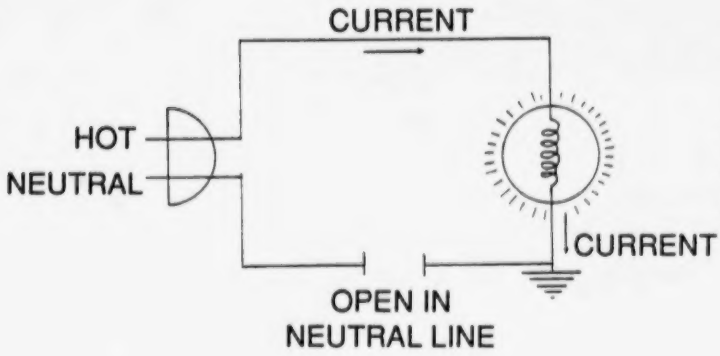


NOTE: The ground terminal should not be wired directly to neutral, as shown at left. Test will not detect this error.

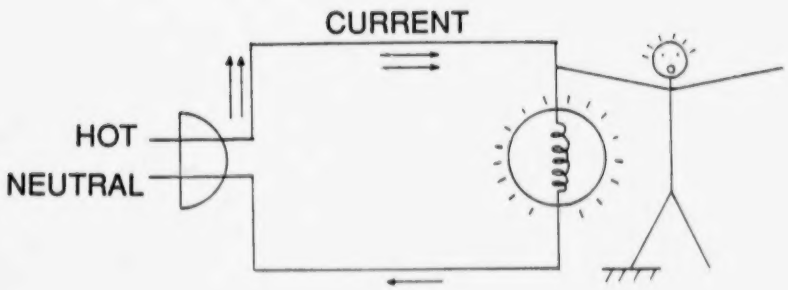
CURRENT PATHS FROM AC POWER



In a normal current path, hot line current and neutral current are equal.

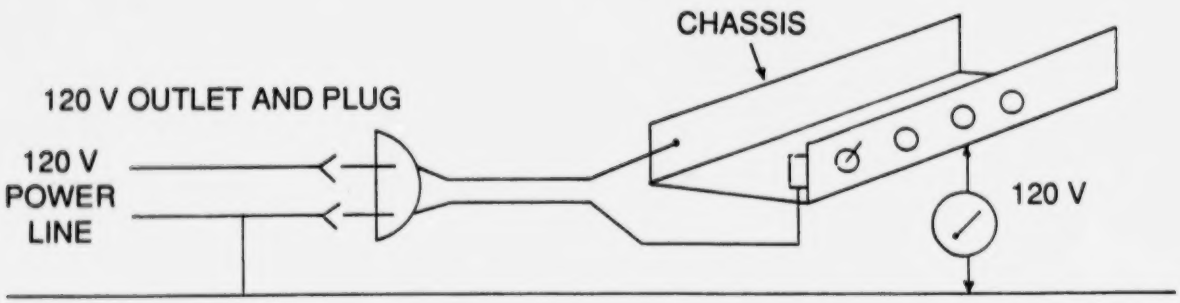


In a ground fault, current returns to ground through a path other than neutral.

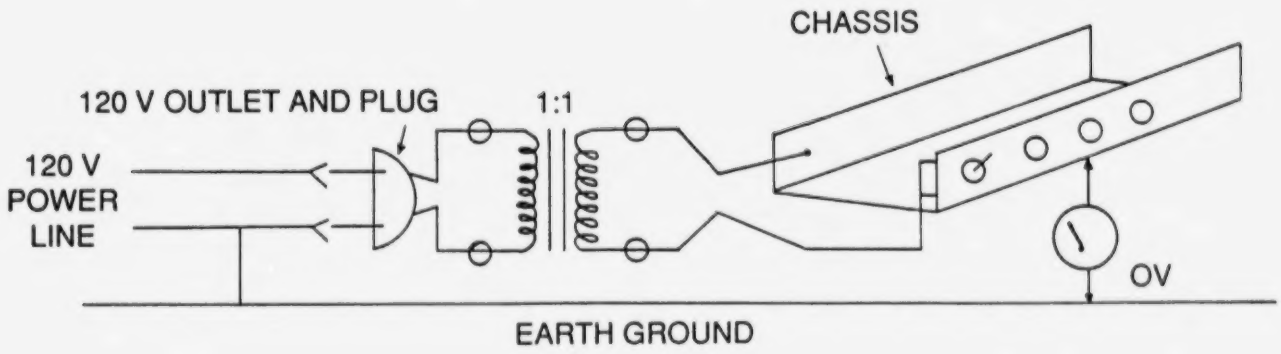


A ground fault can be deadly if the current path includes you.

ISOLATION TRANSFORMERS



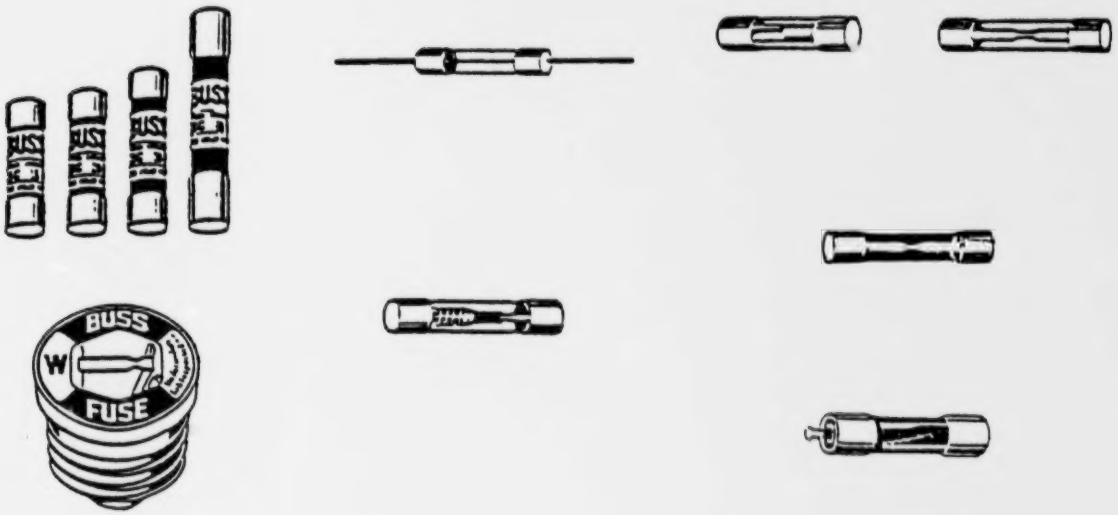
Without an isolation transformer, there is a possibility of 120V running from chassis to ground, creating a shock hazard.



Isolation transformers separate the secondary circuit from the primary power system's ground. This isolation is essential for the safety of personnel who service any piece of equipment without a power transformer for isolation.

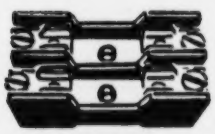
FUSES AND FUSE HOLDERS

FUSES



SCHEMATIC SYMBOL FOR FUSE

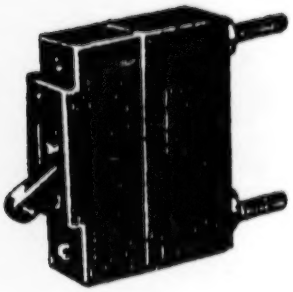
FUSE HOLDERS

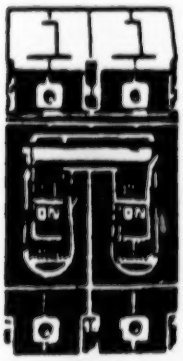


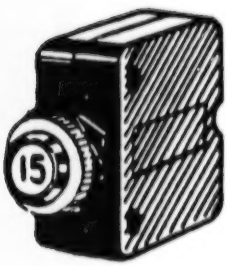
FB2PS

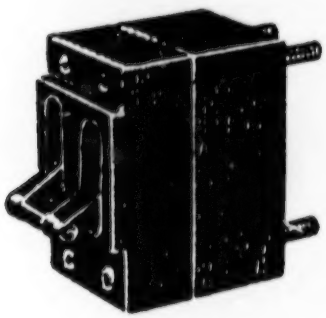
FB1PL

CIRCUIT BREAKERS



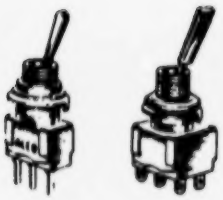




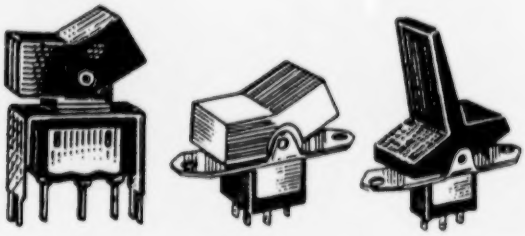


SCHEMATIC SYMBOL FOR
CIRCUIT BREAKER

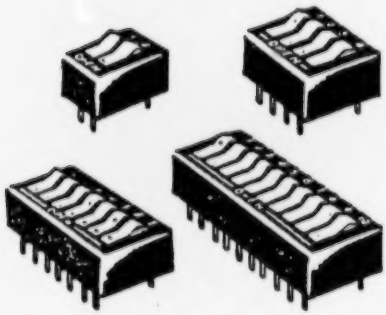
SWITCHES AND THEIR SCHEMATIC SYMBOLS



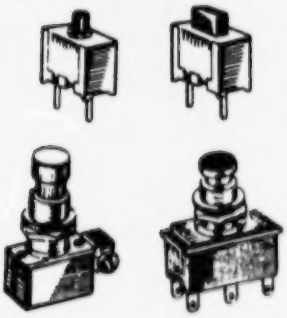
TOGGLE



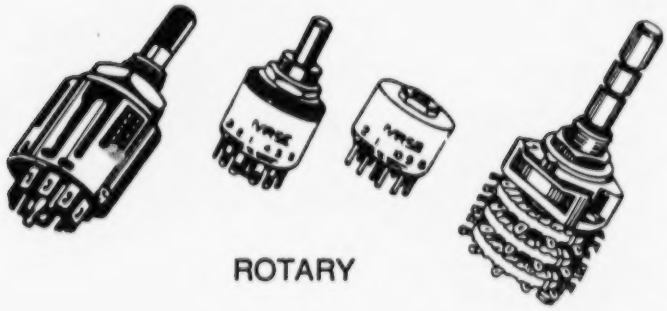
ROCKER



ROCKER DIP

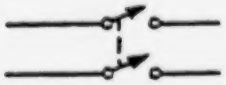


PUSH-BUTTON



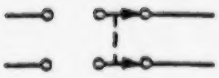
ROTARY

SPST



DPST

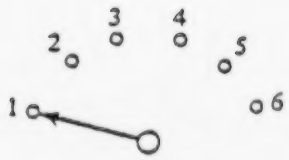
SPDT



DPDT

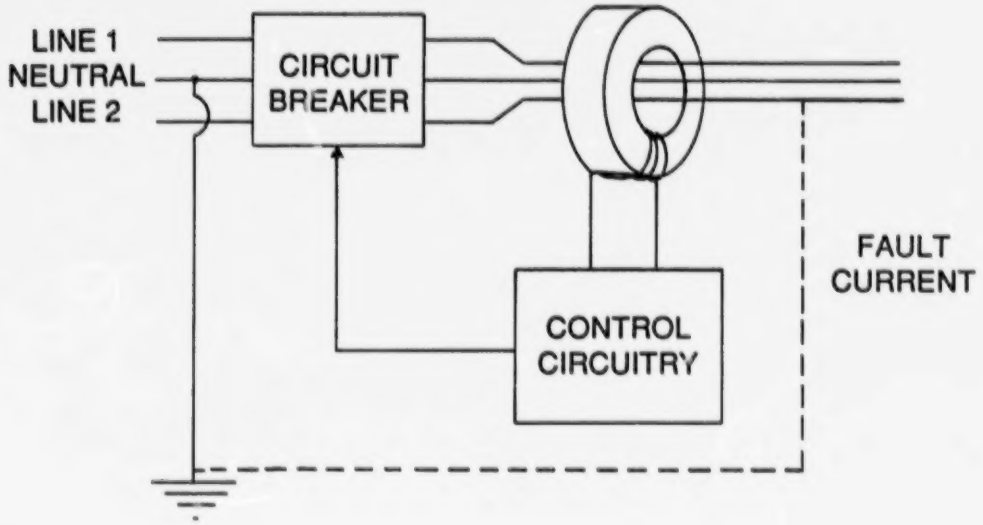
NOPB

NCPB



ROTARY (6-POSITION)

GROUND-FAULT INTERRUPTERS (GFI)



PRINCIPLE OF OPERATION

Both sides of the power line and neutral line pass through the center of a ring-shaped magnetic core. They act as one-turn primary windings of a transformer. The core also has a secondary winding. As long as all of the current that flows through line 1 flows through line 2 or the neutral line, the currents cancel each other and no voltage is induced in the secondary winding.

However, if any of the line current should flow through the ground, the balance in the transformer will be induced in the secondary winding. This voltage is applied to a sensitive solid-state device that operates a circuit breaker that instantly opens all of the lines. If one of the line wires on the load side of the GFI is touched, the circuit immediately opens.

PROTECTION DEVICES

1. List two ratings that are important when selecting fuses, circuit breakers or switches.

   a.

   b.

2. Describe a possible fault that could occur if a fuse with a too-high voltage rating was substituted for one with the correct rating.

3. A fuse, circuit breaker or switch should only be connected in the _____ line of the power source.

4. List six types of switches.

   a. d.

   b. e.

   c. f.

5. Voltages in AC power lines are referenced to _____ .

6. The neutral wire is connected to _____ .

7. A condition in which current returns directly to ground, causing an imbalance between hot and neutral wires to the load, is called a _____ .

8. A _____ can be used to detect ground faults.

9. An _____ should be used when a piece of equipment does not have a power transformer. This device isolates _____ .

ANSWERS TO ASSIGNMENT SHEET 2.1

1. Current, voltage

2. Arcing

3. Hot

4. Any six of the following:
   SPST
   SPDT
   DPST
   DPDT
   NOPB
   NCPB
   Rotary

5. Earth ground

6. Ground

7. Ground fault

8. Ground fault interrupter (GFI)

9. Isolation transformer, secondary voltage from the power source

MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

LESSON 3: GENERAL MEASUREMENT CONCEPTS

I. Terms and definitions

A. Ammeter--device used to measure current

B. Analog meter--multimeter that uses a pointer and multiple scales to display graduated values

C. Digital meter--multimeter that gives a direct digital read-out

D. Multimeter--device used to measure voltage, current and resistance

E. Ohmmeter--direct-reading device used to measure resistance

F. Voltmeter--device used to measure potential difference between two points, usually in volts

II. Basic types of multimeters (TM 3.1, 3.2)

A. Analog

1. Has a needle pointer

2. Has multiple scales

3. One must select the range capable of measuring voltage, current or resistance connected.

B. Digital

1. Direct digital display

2. No human error in interpreting scale (if correct units are observed)

3. Usually easier to operate than analog multimeter

4. An overflow light, a blanket display or a flashing display usually serves as an overflow indicator.

III. Measuring current (TM 3.3)

A. Measured with an ammeter

B. Current must be measured in series.

1. The circuit must be broken and meter leads connected.

2. Power must be removed from the circuit before the connections are made.

3. The meter's polarity markings must be observed on an analog meter.

a. Black is connected to the most negative point of the break.

b. Red is connected to the most positive point of the break.

c. If the meter is connected incorrectly, the needle will deflect backwards and the meter may be damaged.

4. Range of current setting

a. Analog: Start at the highest range and switch to lower ranges until current can be read with reasonable accuracy.

b. Digital: Start at the highest range and lower until overflow occurs, then raise to next highest range.

5. An ammeter must never be connected in parallel since it has a low resistance and could cause a short circuit, damaging the meter or circuit components.

IV. Voltage measurement (TM 3.4)

A. Measured with a voltmeter

B. Measured in parallel

1. Voltage is easier to measure than current because the circuit does not have to be broken.

2. If the measurement is not taken from a known earth ground, power should be removed from the circuit before making connections.

3. Polarity is observed.

a. Black is connected to the most negative point.

b. Red is connected to the most positive point.

c. The needle will deflect backwards on the analog meter if leads are reversed.

4. Range of voltage setting

a. Analog--same procedure as for measuring current

b. Digital--same procedure as for measuring current

V. Measuring resistance (TM 3.5)

A. Measured with an ohmmeter

1. Analog

a. Non-linear scale

b. Adjust for 0 ohm on each range for accurate measurements.

c. Select the proper range for an accurate reading.

2. Digital

a. Direct reading

b. Usually has no ohms adjustment

c. The lowest range capable of measuring connected resistance is the most accurate.

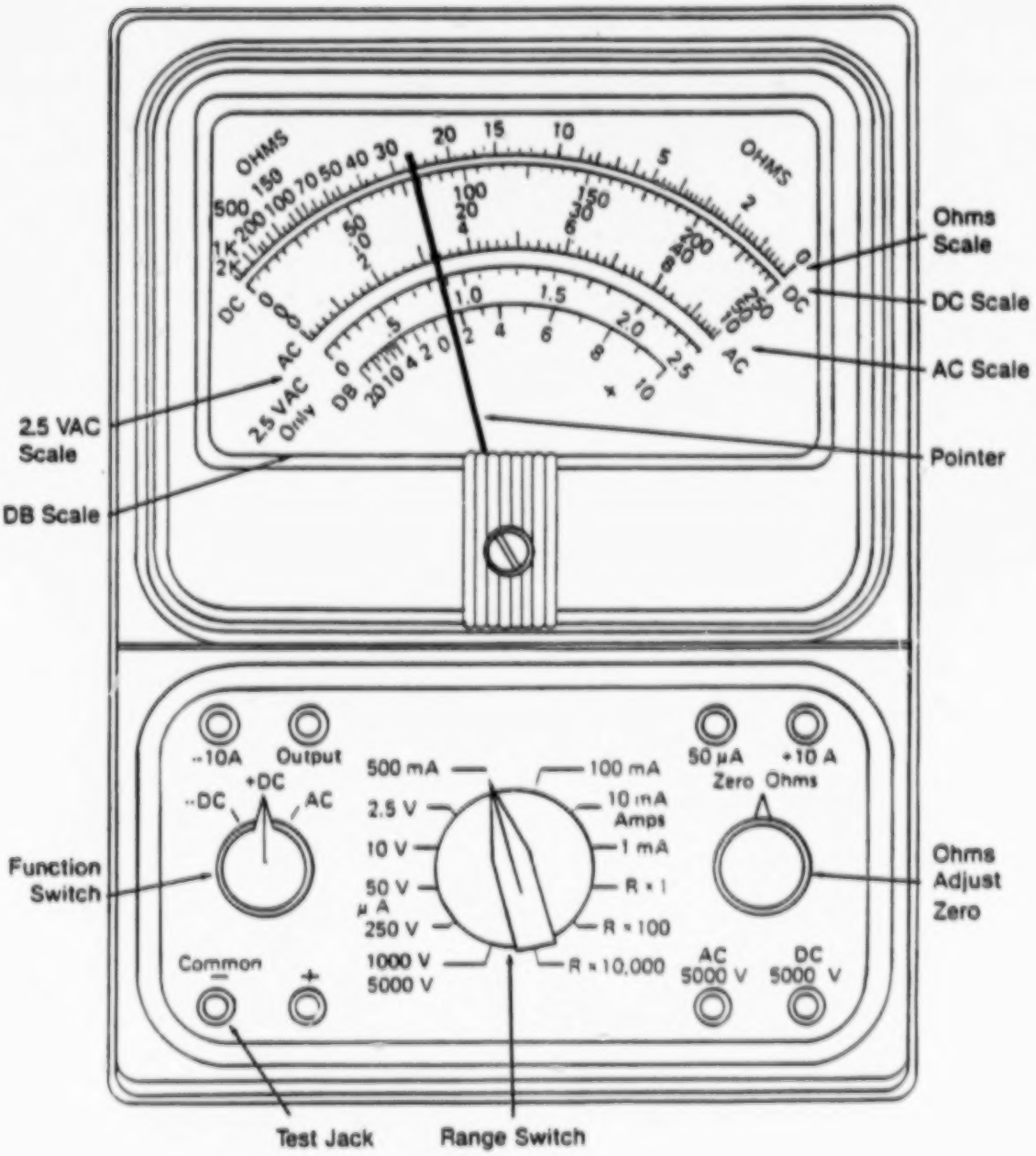
3. Internal battery supply

4. To prevent damage to the ohmmeter, remove power from the resistance to be measured.

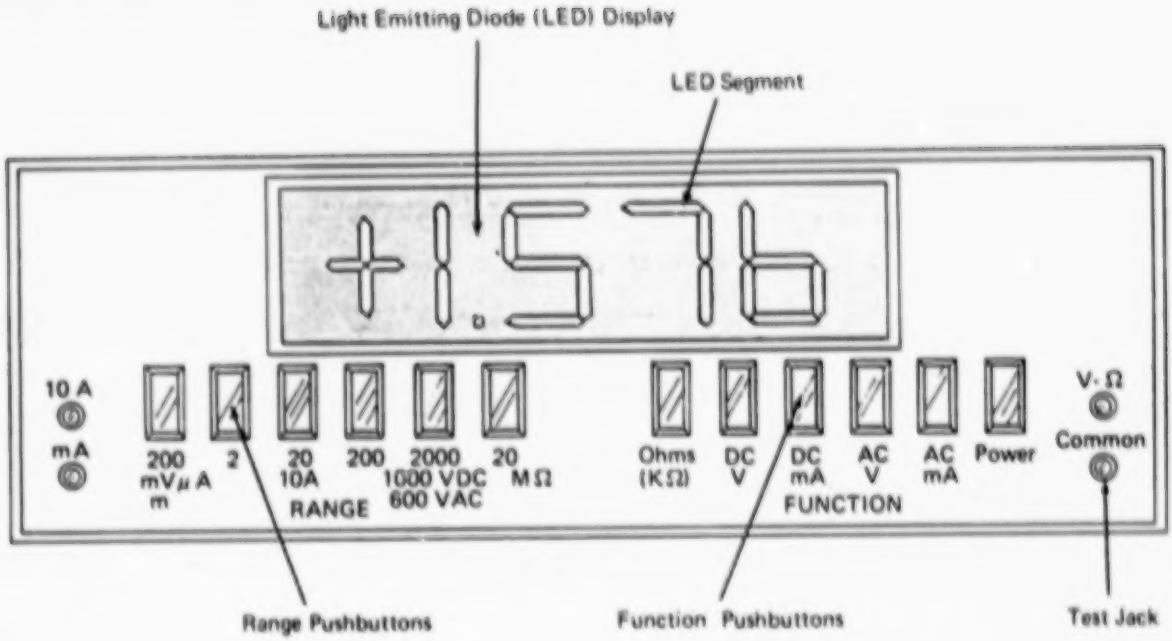
5. The component to be measured should be isolated to prevent an erroneous reading.

6. Ohmmeter leads must be isolated from fingers to prevent bodily resistance from affecting the meter reading.

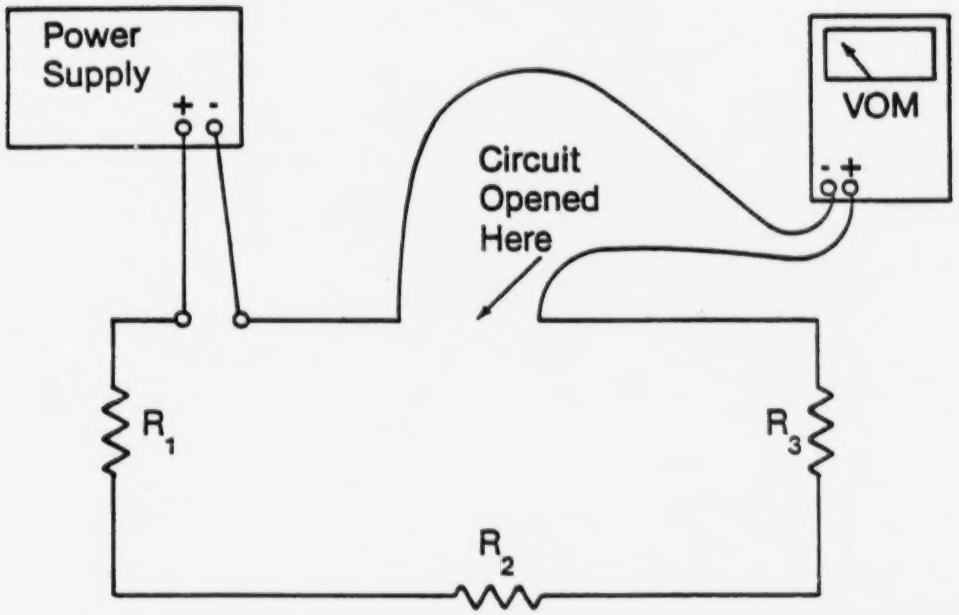
ANALOG MULTIMETER
(Simpson 260)



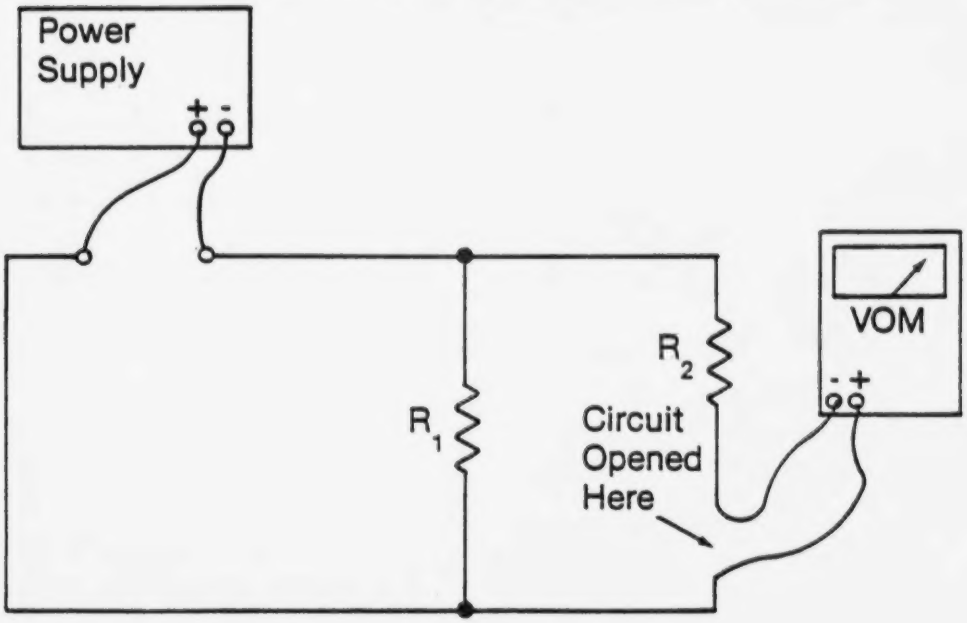
DIGITAL MULTIMETER



CORRECT AMPERAGE MEASUREMENTS

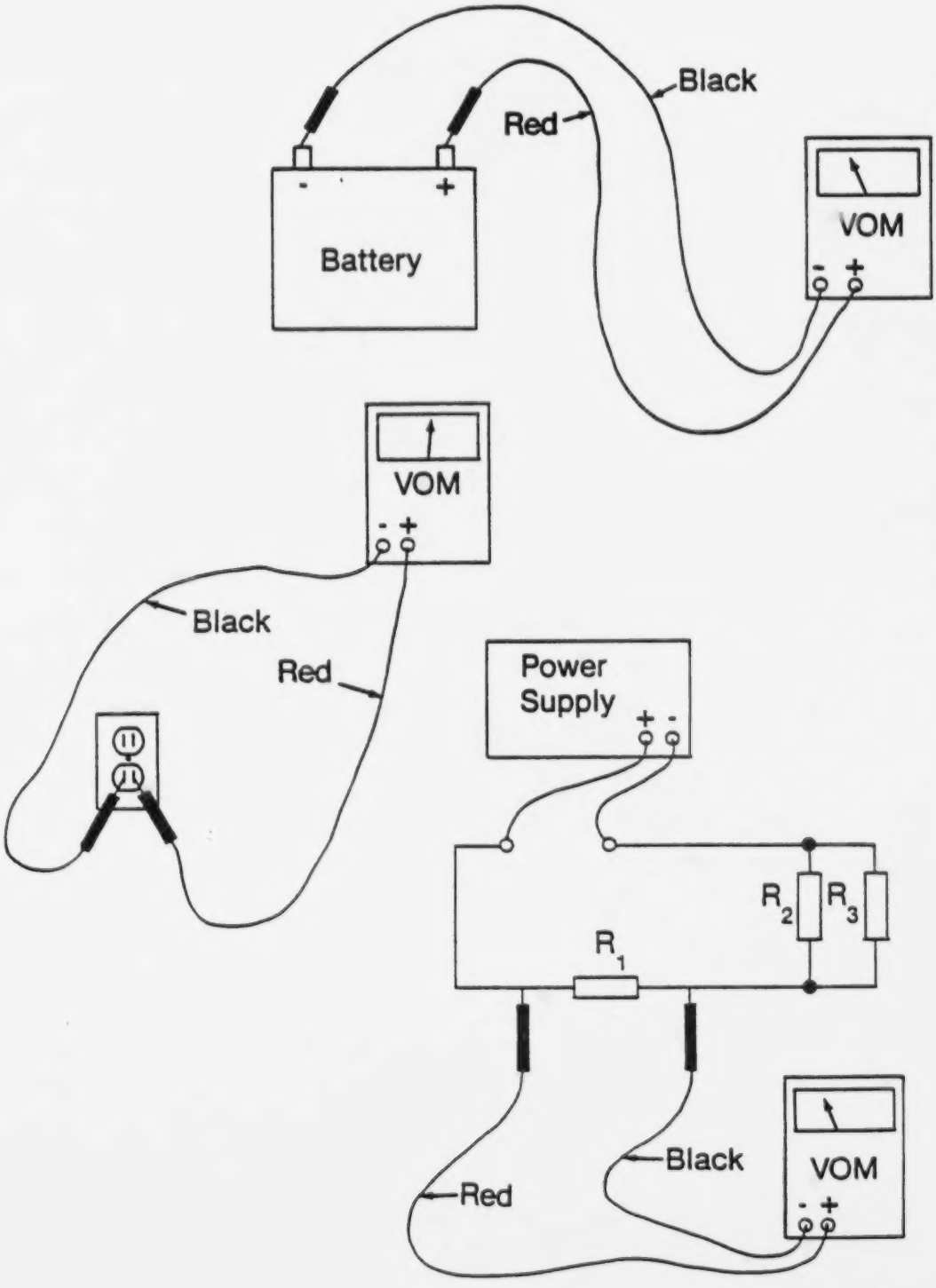


Measuring Amperage in Series Circuits



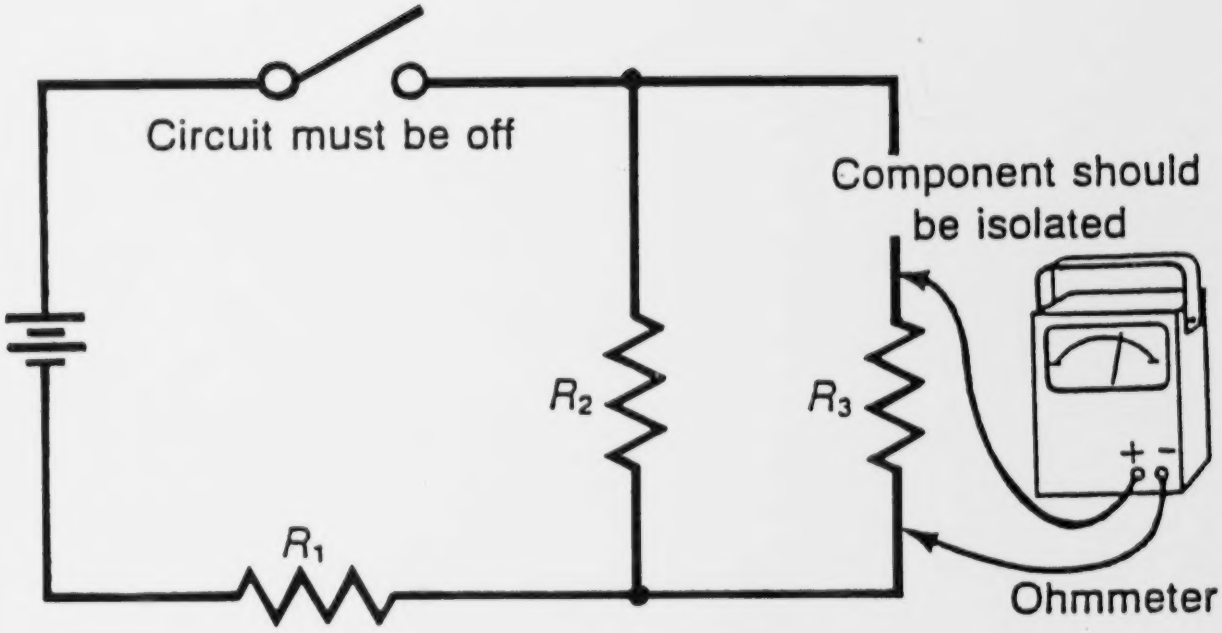
Measuring Amperage in Parallel Circuits

CORRECT VOLTAGE MEASUREMENTS



Safety 103

CORRECT RESISTANCE MEASUREMENTS



MODULE: ELECTRONIC SAFETY

UNIT III: AC SAFETY AND PROTECTION DEVICES

UNIT TEST

Select the option which best answers the question or completes the statement.

____ 1. As compared to digital meters, analog meters _____ .

a. Have direct digital displays
b. Are more difficult to operate
c. Measure only voltage and current
d. Are not subject to human error when interpreting results
e. Are essentially the same

____ 2. What is the microwave frequency band?

a. .3 MHz-3 GHz
b. 3 MHz-30 GHz
c. 30 MHz-300 MHz
d. 300 MHz-3,000 GHz
e. 300-MHz-1,000 Ghz

____ 3. What can microwave radiation cause?

a. Bulk heating effects in molecules
b. Atomic ionization
c. Total removal of all atomic electrons
d. All of the above
e. None of the above

____ 4. Microwave radiation _____ .

a. Is no hazard at any power level
b. Is no more harmful than sunburn
c. Can cause death or blindness at moderate power levels
d. Can cause genetic changes and induce cancer
e. None of the above

____ 5. Analog and digital are two types of _____ .

a. Ammeters
b. Multimeters
c. Ohmmeters
d. Voltmeters
e. All-purpose meters

____ 6. At levels too low to produce significant heating, microwaves _____ .

a. Can be perceived as audio tones
b. Can cause mutations
c. Can influence heart action
d. All of the above
e. None of the above

____ 7. The greatest hazard to eyesight is presented by microwaves at what level?

a. 300 MHz
b. 1,000 MHz
c. 3,000 MHz
d. 10,000 MHz
e. 15,000 MHz

___ 8. What is used to measure current and how must must it be connected?

a. Voltmeter, parallel
b. Voltmeter, series
c. Ammeter, parallel
d. Ammeter, series
e. None of the above

___ 9. To measure current, connect the most positive point in the circuit to the _____ and the most negative point in the circuit to the _____ .

a. Ammeter's black lead, ammeter's red lead
b. Ammeter's red lead, ammeter's black lead
c. Voltmeter's black lead, voltmeter's red lead
d. Voltmeter's red lead, voltmeter's black lead
e. Voltmeter's black lead, voltmeter's white lead

___ 10. The hazard of laser radiation arises principally from its _____ .

a. Intensity
b. Wavelength
c. Coherence
d. High beam divergence
e. None of the above

___ 11. What is the major hazard to the body from laser radiation?

a. Skin
b. Genetic
c. Retinal damage
d. Cataract formation
e. All of the above

___ 12. The skin hazard presented by laser radiation is _____ .

a. Greater for people with dark skins than light skins
b. Negligible if the radiation presents no vision hazard
c. Similar to that presented by fire
d. All of the above
e. None of the above

___ 13. Why is the earth used as ground potential or ground reference?

a. It is a good conductor
b. It is available nearly everywhere
c. All points on it are at substantially the same potential
d. All of the above
e. None of the above

___ 14. It is desirable to ground _____ .

a. All conductors regardless of location
b. Frames of 240V (but not 120V) and equipment
c. Any conducting material that is not energized but which might become energized
d. Frames of all nonelectrical equipment (to avoid short circuits)
e. All of the above

___ 15. One can be electrocuted by coming in contact with the hot wire and _____ .

a. The neutral wire
b. The ground wire
c. Any grounded conducting surface
d. Any of the above
e. None of the above

___ 16. A properly connected three-wire outlet with grounding pin below the power pins will cause a test light to remain unlit when the test probes are connected between the _____ .

a. Neutral and hot slots
b. Neutral and ground slot
c. Hot and ground slot
d. All of the above
e. None of the above

___ 17. A fuse in an electrical circuit should be located in which line?

a. Hot
b. Neutral
c. Ground
d. Any of the above
e. None of the above

___ 18. A fuse should never be placed which line?

a. Hot
b. Neutral
c. Ground
d. Any of the above
e. None of the above

___ 19. What does a ground fault refer to?

a. Short between the neutral and grounding conductors
b. Condition in which current returns directly to ground, causing an imbalance between hot and neutral wires to the load
c. Break in the grounding system
d. All of the above
e. None of the above

___ 20. When measuring voltage or current, start with the _____ range.

a. Lowest
b. Middle
c. Highest
d. All of the above
e. None of the above

___ 21. Which of the following is false?

a. Current and voltage ratings are important when replacing fuses.
b. Circuit breakers are reusable, whereas fuses are not.
c. A slow-blow fuse can be used safely in all applications.
d. Always replace a fuse with one with a higher voltage rating than the original's.
e. None of the above

___ 22. Which of the following is true?

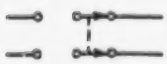
a. On-off switches should not be connected on the hot side of the power line.
b. Voltage and current ratings of switches really do not matter.
c. Isolation transformers separate the ground and neutral lines on the AC outlet.
d. Isolation transformers should be used when servicing equipment without a power transformer.
e. None of the above

Match the following.

a. Ammeter
b. Analog meter
c. Digital meter
d. DPDT
e. DPST
ab. NCPB
ac. NOPB
ad. Ohmmeter
ae. Rotary
bc. SPDT
bd. SPST
be. Voltmeter

___ 23.

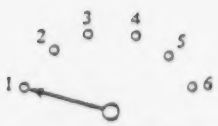
___ 24.

___ 25. 

___ 26.

___ 27.

___ 28.

___ 29. 

___ 30. Has multiple scales and a pointer

___ 31. Used only when power is disconnected, measures resistance

___ 32. Direct digital readout

___ 33. Connected in parallel; measures potential difference

___ 34. Connected in series; measures current

Match the following terms and definitions.

____	35.	Condition in which current returns directly to ground; causes an imbalance between hot and neutral wires to the load	a. Circuit breaker
____	36.	Device used to measure voltage, current and resistance	b. Fuse
____	37.	Device used by operator to control circuit power	c. Ground fault
____	38.	Distance in space between two points with the same magnitude and direction in a propagated wave	d. Ground fault interrupter
____	39.	Emission of energy through space or through a material medium in the form of waves	e. Isolation transformer
____	40.	Metal conductor that melts at a predetermined current level	ab. Laser
____	41.	One-to-one transformer that isolates the secondary voltage from the power line	ac. Multimeter
____	42.	Protection device designed to break the power circuit if a ground fault exists	ad. Radiation
____	43.	Protective device that opens when excessive current flows in a circuit; can be reset	ae. Switch
			bc. Wavelength

____ 44. For a safe, accurate reading, list three precautions to observe when measuring resistance.

a.

b.

c.

ANSWERS TO UNIT TEST

1.	b	(A7)
2.	c	(A6)
3.	a	(A6)
4.	c	(A6)
5.	b	(A7)
6.	c	(A6)
7.	c	(A6)
8.	d	(A7)
9.	b	(A7)
10.	a	(A6)
11.	c	(A6)
12.	d	(A6)
13.	d	(A7)
14.	c	(A7)
15.	d	(A7)
16.	b	(A7)
17.	a	
18.	c	
19.	b	(A7)
20.	c	(A7)
21.	d	
22.	d	(A7)
23.	e	
24.	bd	
25.	d	
26.	ab	
27.	ac	
28.	bc	
29.	ae	
30.	b	(A7)
31.	ad	(A7)
32.	c	(A7)
33.	be	(A7)
34.	a	(A7)
35.	c	(A7)
36.	ac	(A7)
37.	ae	
38.	bc	(A7)
39.	ad	(A6)
40.	b	
41.	e	(A7)
42.	d	(A7)
43.	a	

44. Remove power; isolate component from circuit; isolate meter leads from fingers. (A7)